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NATIONAL DAM INSPECTION PROGRAM. QUAKAKE DAM (NDI ID NUMBER PA---ETC(U)
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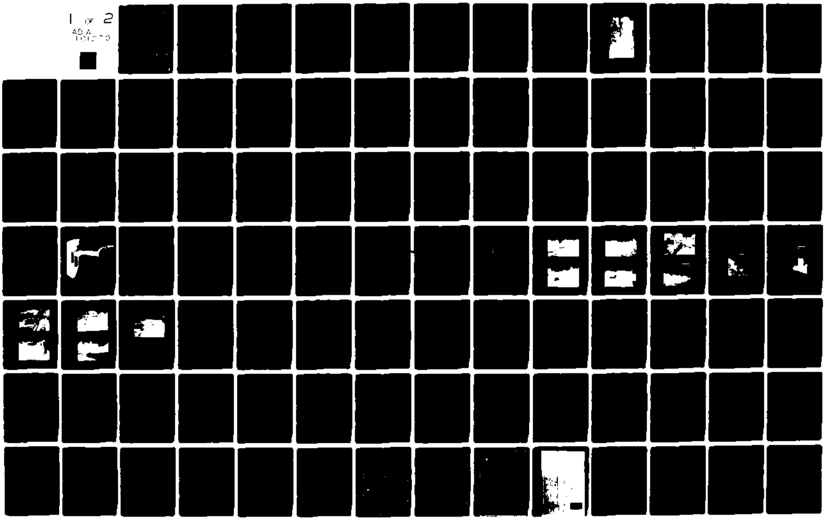

LEVEL II

DELAWARE RIVER BASIN

QUAKAKE CREEK, CARBON COUNTY

PENNSYLVANIA

QUAKAKE DAM

NDI ID NO. PA-00613

DER ID NO. 13-11

HAZLETON CITY WATER AUTHORITY

AD A101270

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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USAED, Baltimore

B. REPORT TITLE AND/OR NUMBER
Quakake Dam NDI No. PA 00613

C. MONITOR REPORT NUMBER

D. PREPARED UNDER CONTRACT NUMBER
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DELAWARE RIVER BASIN

QUAKAKE CREEK, CARBON COUNTY

PENNSYLVANIA

QUAKAKE DAM

NDI ID No. 00613
DER ID No. 13-11

HAZLETON CITY WATER AUTHORITY

6

National Dam Inspection Program. Quakake Dam (NDI ID Number PA-00613, DER ID Number 13-11), Delaware River Basin, Quakake Creek, Carbon County, Pennsylvania. Phase I Inspection Report.

PHASE I INSPECTION REPORT

NATIONAL DAM PROGRAM

Prepared by:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

QUAKAKE DAM

NDI ID No. PA-00613, DER ID No. 13-11

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION
AND
RECOMMENDED ACTION

Name of Dam:	Quakake Dam NDI No. PA 00613 DER No. 13-11
Size:	Small (15 feet high; 140 acre-feet)
Hazard Classification:	High
Owner:	Hazleton City Water Authority Hazleton, Pa.
Stated Located:	Pennsylvania
County Located:	Carbon
Stream:	Quakake Creek
Date of Inspection:	4 December 1980 and 10 March 1981.

The visual inspection and review of available design and construction data indicate that Quakake Dam is in fair condition. The limited spillway capacity is the primary deficiency which causes concern for the safety of this facility. The dam in its present condition is considered to be unsafe, non-emergency. In accordance with the guidelines provided, the spillway design flood (SDF) ranges between 1/2 the PMF to the full PMF. Based on the size of dam, the SDF selected was 1/2 the PMF.

The hydrologic and hydraulic computations indicate that the combination of reservoir storage and spillway discharge capacity will pass only 9% of the PMF prior to overtopping the embankment. Overtopping the dam could cause failure, which would lead to a significant increase in downstream loss of life and property damage. Therefore, the spillway for Quakake Dam is considered to be seriously inadequate.

QUAKAKE DAM

The following measures are recommended for immediate action:

1. The owner should immediately retain a qualified professional engineer, experienced in dam design and construction, to perform detailed hydrologic and hydraulic studies to determine remedial measures necessary for providing adequate spillway capacity for this facility.

2. It should be assured that the corewall is adequately backfilled to prevent seepage from developing as a result of the recent construction. In addition, the cracks in the corewall to the left of the spillway should be repaired.

3. The low area adjacent to the right spillway abutment should be properly backfilled.

4. Trees and brush should be cleared from the embankment.

5. The deteriorated concrete of the spillway walls should be repaired.

6. A formal surveillance and downstream emergency warning system should be developed for use during periods of heavy or prolonged precipitation.

7. An operation and maintenance manual or plan should be prepared for use as a guide in the operation and maintenance of the dam during normal and emergency conditions.

8. A schedule of regular inspection by a qualified engineer should be developed.

APPROVED BY:

DEPARTMENT OF THE ARMY

BALTIMORE DISTRICT, CORPS OF ENGINEERS

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

DATE: 18 MAY 81

QUAKAKE DAM

OVERVIEW

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of non-federal dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life and property.

1.2 Description of Project.

a. Description of Dam and Appurtenances. Quakake Dam is an earthfill structure with concrete corewall approximately 15 feet high and 655 feet in length (including spillway). The embankment crest originally served as a railroad bed, which is now inactive. The 40 foot wide spillway is an uncontrolled ogee weir located near the center of the dam. The outlet works consist of a 36 inch diameter conduit through the center of the spillway weir and a 30 inch water supply line which has an intake structure located near the left abutment. The 36 inch conduit is controlled by a slide gate mechanism located on the upstream face of the spillway weir.

NOTE: All elevations in this report are referenced to U.S.G.S. Plaque - 27 E.W.S. (1942), elevation 1110.41. This plaque is located on the left spillway wall.

b. Location: Packer Township, Carbon County, Pennsylvania
U.S.G.S. Quadrangle - Weatherly, Pa.
Latitude 40° 54.9'; Longitude 75° 51.6'
Refer to Plates E-I and E-II.

c. Size Classification: Small: Height - 15 feet, Storage - 140 acre-feet.

d. Hazard Classification: High (Refer to Section 3.1.e)

e. Ownership: Hazleton City Water Authority
Mr. Robert Zientek, Manager
231 S. Wyoming St.
Hazleton, Pa. 18201

f. Purpose: Water Supply.

g. Design and Construction History: No design or construction information is known to exist for the original dam construction. The dam was apparently built around 1897. Several drawings of the dam are available which provide general details of the existing facility (See App. E).

A new combined water supply intake and outlet works structure was under construction at the time of inspection. Drawings showing this work are also included in Appendix E.

h. Normal Operating Procedure. The reservoir is normally maintained at the crest of the ogee spillway. Inflow which exceeds the water supply draft flows over the spillway weir. The owner's representative stated that the Delaware Water Authority requires that a minimum flow of 1 million gallons/day be maintained at all times on Quakake Creek downstream of the dam.

3. Pertinent Data.

a. Drainage Area (square miles)

From files:	16.3
Computed for this report	17.2
Use:	17.2

b. Discharge at Damsite (cubic feet per second)

Maximum known flood	unknown
Outlet works with maximum pool (El.1111.0)	85
Spillway with maximum pool (El.1111.0)	1430

c. Elevations (feet above mean sea level)

Top of Dam	
Design	1112.0
Existing	1111.0
Normal pool (Spillway Crest)	1106.2
Spillway Crest	
Design	1107.5
Existing	1106.2
Outlet Works	
Old	
Upstream Invert	1100.8
Downstream Invert	1100.7
New (under construction - multilevel intake)	
Upstream Drawdown invert	1098.0
Downstream Invert	1097.91
Streambed Invert	1096.0

d. Reservoir Length (feet)

Normal pool (El.1106.2)	1100
Maximum pool (El.1111.0)	1200

e. Storage (acre-feet)

Normal pool (El.1106.2)	65
Maximum pool (El.1111.0)	140

f. Reservoir Surface (acres)

Normal pool (El.1106.2)	13
Maximum pool (El.1111.0)	20.5

g. Dam

Note: Refer to plates in Appendix E for plans and sections.

Type	earthfill structure w/concrete corewall, covered with cinders
Length	655 feet including spillway
Top Width	30 feet.
Height	15 feet.
Side Slopes	
Upstream	varies, 1.3H:1V to 2H:1V
Downstream	varies, 1.3H:1V to 2H:1V
Zoning	earthfill w/conc. corewall
Cutoff	18 inch corewall
Grouting	None

h. Outlet Works.

Old

Type	36 inch diameter conduit through spillway weir
Closure	36 inch slide gate on upstream side of weir

New (under construction)

Type	multilevel intake, with 2-30 inch diameter pipes
Closure	30 inch slide gates, upstream

i. Spillway

Type	ogee crest weir with steel cap
Location	center of dam
Length	40 feet
Crest Elevation	1106.2 M.S.L
Freeboard	4.8 feet
Approach Channel	reservoir
Downstream Channel	earth & rockfill

SECTION 2

ENGINEERING DATA

2.1 Design.

The available data for Quakake Dam consist of files provided by PennDER. Information available includes a permit application report with a general description of the proposed design, PennDER inspection reports, various related correspondence, and line drawings dated 1915 showing a cross-section, general plan, and longitudinal section of the dam. Plans are also available for the modifications currently underway to the dam's water supply intake system.

2.2 Construction.

No information relative to the construction of the dam is known to exist.

The only known post-construction changes are those presently being made to the water supply intake system. The owner's representative (Mr. Robert Zientek) stated that some repairs to the corewall were made after storm damage in 1955.

2.3 Operation

No formal records of operation or maintenance are known to exist. Mr. Zientek stated that there is a resident pump operator who has responsibility for maintenance of several dams owned by the Authority, and who also checks the dams during high water events. The outlet works is operated when necessary to maintain the required minimum flow on Quakake Creek of 1 million gallons per day. Mr. Zientek also stated that, since several of the Hazleton City Water Authority dams had already been inspected under the National Dam inspection program, emergency warning and operation plans were already being developed for all dams owned by the Authority, including Quakake Dam. These plans are being developed by Westmoreland Engineering, Monessen, Pa.

The most recent PennDER inspection (Aug. 1962) indicated that the dam was in satisfactory condition.

2.4 Evaluation

a. Availability. All available written information was contained in the permit files provided by PennDER.

b. Adequacy. The available data, including that collected during the recent detailed visual inspection, are considered to be adequate to make a reasonable assessment of the dam.

SECTION 3

VISUAL INSPECTION

3.1 Observations.

a. General. The overall appearance and general condition of the dam and appurtenances are fair. Noteworthy deficiencies are described briefly below. The visual inspection checklist, field sketch and profile are provided in Appendix A. Photographs taken during the inspection are provided in Appendix C.

On 10 March 1981, a brief review inspection was made in order to determine if any significant changes had occurred in the structure since the initial inspection of 4 December 1980. The changes that did occur are noted when appropriate. The reservoir pool was essentially at spillway crest during the initial inspection and approximately six inches above the crest on the day of the review inspection. A representative of the owner was interviewed at his office in Hazleton but was not present for the actual inspection.

b. Embankment. The embankment consists of an abandoned double track railroad bed backed up by an 18 inch thick concrete corewall with select earthfill upstream of the corewall. The top of the corewall is approximately two feet above the embankment crest. The wall is in good condition except for an eroded depression at the water line just left of the spillway and a large vertical crack ten feet left of the spillway. The crack has been noted in

previous inspections but repairs have been minimal or nonexistent. The eroded depression is about 4 inches deep and 2 feet in diameter. The apparent cause is ice and debris. A 30 foot long section of this corewall is exposed almost down to its base to allow for the placement of a new 30 inch ductile iron water supply line and a 30 inch ductile iron reservoir drainline. On the day of the review inspection, the new pipes had been extended through the wall and the cofferdam area on the upstream side had been allowed to refill with water. Water was seeping through the wall at approximately 2 gallons per minute approximately six feet below the upstream water surface.

The upstream slope is 1V:1.3H to the right of the spillway and 1V:2H to the left. The upstream slope is protected with 6 to 8 inch stone below the waterline. Erosion does not appear to be a problem. The crest width is 30 feet. The downstream slope varies from 1V:1.5H to 1V:2H to the right of the spillway. The slope left of the spillway is irregular due to ongoing construction. The upstream face to the right of the spillway and the entire downstream face are covered with brush and trees. The trees on the downstream slope range up to 30 inches in diameter. There is an eroded area on the embankment crest and downstream slope just to the right of the spillway.

c. Appurtenant Structures. New outlet works are presently being constructed for the dam. A new intake structure located in the lake approximately 48 feet upstream of the corewall is essentially complete except for the installation of hatches and a bridge from the dam. This structure contains multi-level intakes with slide gate controls. Two 30 inch diameter ductile iron pipes extend from this structure through the corewall. One pipe

will eventually extend through the left spillway wall downstream of the weir. This outlet will be fitted with a flap gate and will serve as the pond drain. The other pipe will be for water supply. This new structure appeared to be well constructed.

The current outlet works consists of a 36 inch diameter conduit through the center of the spillway weir and a 30 inch water supply line housed in a concrete box with trash screen located at the left abutment. The water supply line is still operational and extends to a pump house 500 feet away. The slide gate on the upstream face of the weir is in the closed position and the operating mechanism appears inoperable. A six inch iron pipe, which was the original water supply line, rises out of the lake, extends over and down the face of the weir and disappears into natural ground just downstream of the dam. The status of this line is unknown.

The spillway is a 40 foot long concrete ogee section with steel plates on the crest. The concrete is in good condition. The side walls are large cut stone masonry. These walls orginally also served as abutments for a railroad bridge. There is some erosion and deterioration of the walls in the vicinity of the flow line. Generally, these walls are in fair condition. The discharge channel between these walls is lined with large slabs of stone. There does not appear to be any erosion or deterioration of these slabs. Below this point the channel begins to narrow and is a natural earth and rock channel. There are no obstructions to flow either upstream or downstream of the weir.

d. Reservoir Area. The left side of the reservoir area is wooded and rises steeply from the lake. The right side is flat to moderate and also wooded. These slopes appear stable.

e. Downstream Channel. Quakake Creek, across which the dam is constructed, passes under Pennsylvania Route 93 bridge approximately 400 feet downstream of the dam. Just upstream of this bridge several houses are located in the flood plain. The first floors are 8 feet above the streambed. Immediately downstream of the bridge is a commercial fuel supply firm with several storage tanks adjacent to the stream. Failure of Quakake dam would create a potential hazard for the loss of more than a few lives and extensive property damage. Below this point Quakake Creek becomes confined and flows through a wooded and uninhabited area until joining Black Creek 2.3 miles downstream of the dam.

f. Evaluation. The deficiencies noted are basically limited to maintenance. The removal of the trees and brush from the embankment and repair of the eroded concrete adjacent to the spillway weir are recommended. The new outlet works will permit drawing down of the reservoir should repairs to the dam be required. In connection with this new construction, the exposed section of corewall should be sealed on the upstream side before backfilling.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure. The lake is maintained at the level of the spillway crest, elevation 1106.2. Inflow in excess of the water supply draft flows over the spillway. Large inflows in excess of the spillway capacity would overtop the embankment beginning at the low point top of dam adjacent to the left abutment. No formal operations manual exists.

4.2 Maintenance of Dam. The overall condition of the dam and appurtenances as observed by the inspection team was fair. A new water supply intake and drawdown facility was being built. No formal maintenance manual exists.

4.3 Maintenance of Operating Facility. See Section 4.2 above.

4.4 Warning System. No formal warning system exists; however, plans are currently being developed by a consultant to the water authority.

4.5 Evaluation. Overall maintenance of the facility appears to be adequate at this time. The spillway concrete and corewall have undergone some deterioration; however, it does not appear to be a problem at this time. The new drawdown pipe will provide the means to lower the lake if necessary in the future. Formal operation and maintenance manuals are recommended to insure that all needed maintenance is identified and performed regularly. In addition, a formal warning system for the protection of downstream inhabitants

should be developed. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

SECTION 5

HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data. No design reports, calculations or miscellaneous design data are known to exist for the facility; however, a few drawings of the facility were in the PennDER and owner's files. Drawings of the new water supply intake and outlet structure were also obtained from the owner. Refer to Appendix E for these drawings.

5.2 Experience Data. Records of reservoir levels and/or spillway discharges are not available other than a report on discharge through the spillway during the March 1936 flood. Overtopping is not known to have occurred.

5.3 Visual Observations. On the date of the inspection, no conditions were observed that may prevent the facility from operating as intended.

5.4 Method of Analysis. The facility has been analyzed in accordance with procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. This analysis has been performed using a modified version of the HEC-1 program developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. Capabilities of the program are briefly outlined in the preface contained in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with the procedures and guidelines contained in the National Guidelines for Safety Inspection of dams for Phase I Investigations, the SDF for Quakake Dam ranges between one-half the Probable Maximum Flood (PMF) and the full PMF. This classification is based on the relative size of the dam (small), and the potential hazard to downstream development in the event of dam failure (high). Due to the small storage (approximately 140 ac-ft) and small height (15 feet), the SDF selected was one-half PMF.

b. Results of the Analysis. Quakake Dam was evaluated under near normal operating conditions. The starting lake elevation was set at the spillway crest, El.1106.2.

The spillway crest to top of dam (low point) has a freeboard of approximately 4.8 feet. Flood hydrographs and spillway calculations were developed and the following results were obtained.

Spillway Capacity at Top of Dam	1430 CFS
Peak SDF (1/2 PMF) Inflow	7360 CFS

The overtopping analysis (using HEC-1DB) indicated that the discharge/storage capacity of Quakake Dam is 9% of the PMF prior to overtopping the embankment. Under one-half PMF conditions, the dam is overtopped for 8.3 hours to a maximum depth of 3.6 feet. Since the SDF for

this dam is one-half PMF, it can be concluded that Quakake Dam has a high potential for overtopping, and thus, for breaching by floods of less than SDF magnitude.

To determine if the spillway is seriously inadequate, these conditions must be met:

(i) There is a high hazard to loss of life from large flows downstream of the dam.

(ii) The spillway is not capable of passing one-half PMF without overtopping the dam and causing failure.

(iii) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream of the dam from that which would exist just before overtopping.

Since Quakake Dam meets the first two conditions, the third condition must be evaluated; therefore, a breach analysis was performed.

The modified HEC-1 computer program was used for the breaching analysis. The computer program requires that a failure elevation be given to the model so that failure may commence. It was assumed that the dam could withstand up to 0.5 foot of overtopping for short durations. Therefore, the water surface elevation selected to cause failure was elevation 1111.5.

Four breach models were analyzed under conditions that would approximate 0.5 foot of overtopping. The flood selected to cause breaching was 13% of the PMF. Of the four plans, Plan 1 was a non-breach analysis used to provide a means of direct comparison between failure and non-failure conditions at downstream locations for the same flood event. Failure times in the three remaining plans were 0.33 hr (Plan 2), 1.00 hr (Plan 3), and 2.00 hrs (Plan 4). Downstream damage elevations and locations are shown in Appendix D and E of this report. Page D-12 of Appendix D provides peak outflows and changes in stage at downstream damage centers. As indicated in the table, failure conditions significantly increase the hazard to loss of life when compared to non-failure conditions. Breach geometry and location are also discussed in Appendix D.

5.6 Spillway Adequacy. Under existing conditions Quakake Dam can accommodate 9% of the PMF prior to overtopping. Should an event in excess of this occur, the dam would be overtopped and could possibly fail. Since the failure of this dam significantly increases the hazard to loss of life or property damage at existing downstream residences, this spillway is considered to be seriously inadequate.

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SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) Embankment.

Visual observations of Quakake Dam did not reveal any signs of noticeable distress in the structure. The dam is an earthfill structure that has an 18 inch thick corewall, which is curved slightly upstream. The dam crest measures 30 feet wide and has upstream and downstream slopes that vary from about 1.3H:1V to 2H:1V. Riprap is very sparse on the upstream slope; however, erosion is not a problem. The crest and downstream slope are covered with 10 inches or more of cinders. These cinders offer little resistance to erosion, but the removal of these cinders should not affect the dam stability. Erosion has occurred in the crest and downstream slope beside the right spillway wall. Continued erosion in this area will remove support for the spillway wall.

(2) Appurtenant Structures.

The dam has a 40 foot long concrete spillway, an outlet works, and a water supply intake structure. The water supply intake located at the left

abutment appears to be in fair structural condition. The outlet works has a 36 inch diameter pipe through the spillway and an upstream slide gate that is inoperative. A new structure is being constructed left of the spillway that will serve as a water supply intake and an outlet works. The concrete spillway, spillway walls, and downstream spillway channel are in fair condition. The spillway walls were used to support girders for two railroad bridges, and the spillway channel is paved with large slabs of stone that protect the walls form being undermined.

b. Design and Construction Data.

(1) Embankment.

No design or construction data exist. Apparently, the dam was constructed about 1897 as it presently is. A capstone on the spillway has a date of 1897. Drawings and photographs dated 1915 indicate that the dam was essentially the same as when recently inspected. The noted differences are that the railroad bridge girders have been removed, the superelevated railroad curve has been leveled, and the embankment is now covered with trees.

(2) Appurtenant Structures.

No design or construction data exist. Drawings from 1915 and early photographs show the appurtenant structures were the same as when inspected, except the water intake structure has been rebuilt.

c. Operating Records.

None.

d. Post - Construction Changes.

No applications for or notifications of changes exist. Several minor changes have been made as stated in 6.1b.

e. Seismic Stability.

The dam is located is Seismic Zone 1. From visual observations, the dam is considered to be statically stable. Therefore, based on the recommended criteria for evaluation of seismic stability of dams, the structure is presumed to present no hazard from an earthquake.

SECTION 7

ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment.

a. Safety. The visual inspection and review of available design and construction data indicate that Quakake Dam is in fair condition. The limited spillway capacity is the primary deficiency which causes concern for the safety of this facility. The dam in its present condition is considered to be unsafe, non-emergency. In accordance with the guidance provided, the spillway design flood (SDF) ranges between 1/2 the PMF and the full PMF. Based on the size of dam, the SDF selected for this facility was 1/2 the PMF.

The hydrologic and hydraulic computations indicate that the combination of reservoir storage and spillway discharge capacity will pass only 9% of the PMF prior to overtopping the embankment. Therefore, in accordance with the criteria outlined and evaluated in Section 5.5, the spillway for Quakake Dam is considered to be seriously inadequate.

b. Adequacy of Information. The design and construction data contained in PennDER files, in conjunction with data collected during the recent visual inspection, are considered to be adequate for making a reasonable assessment of this dam.

c. Urgency. The recommendations presented below should be implemented immediately.

d. Necessity for Additional Studies. The results of this inspection indicate a need for additional detailed hydrologic and hydraulic (H&H) studies to provide an adequate spillway facility for this dam.

7.2 Recommendations.

1. The owner should immediately retain a qualified professional engineer, experienced in dam design and construction, to perform detailed hydrologic and hydraulic studies to determine remedial measures necessary for providing adequate spillway capacity for this facility.

2. It should be assured that the corewall is adequately backfilled to prevent seepage from developing as a result of the recent construction. In addition, the cracks in the corewall to the left of the spillway should be repaired.

3. The low area adjacent to the right spillway abutment should be properly backfilled.

4. Trees and brush should be cleared from the embankment.

5. The deteriorated concrete of the spillway walls should be repaired.

6. A formal surveillance and downstream emergency warning system should be developed for use during periods of heavy or prolonged precipitation.

7. An operation and maintenance manual or plan should be prepared for use as a guide in the operation and maintenance of the dam during normal and emergency conditions.

8. A schedule of regular inspection by a qualified engineer should be developed.

APPENDIX A

CHECKLIST - VISUAL INSPECTION

Check List

Visual Inspection

Phase 1

Name Dam Quakake Dam County Carbon State Pennsylvania

*Date(s) Inspection 4 Dec 80 Weather Clear Temperature 30's

Pool Elevation at Time of Inspection 1106.2 M.S.L. Tailwater at Time of Inspection 1099.4 M.S.L.

Inspection Personnel:

J. Bianco, C.O.E.	E. Hecker, C.O.E	
B. Cortright, C.O.E. (Recorder)		
J. Evans, C.O.E.		

*Review Inspection:

Date 10 Mar 81 Weather Clear Temperature 40^{o}

Pool Elevation 1106.7 M.S.L. Tailwater Elevation 1099.7 M.S.L.

Personnel:

J. Bianco, C.O.E. B. Cortright, C.O.E. P. Maggitti, C.O.E.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS
Noticeable Seepage	None except through exposed portion of corewall est. 2 gpm. Six feet below water surface.
Junction of Embankment with: Abutments Spillway	Abutments - Low at left abutment Spillway - Low area behind rt. spillway wall
Cracking: Embankment Corewall	Embankment - None Corewall - Vertical crack 10' left of spillway; eroded concrete 4" deep x 2 feet diam. on u/s face left of spillway.
Crest Alignment: Horizontal Vertical	Good; curved upstream
Unusual Movement or Cracking at or Beyond Toe	None

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS
Sloughing or Erosion: Embankment Crest/Slopes Abutment Slopes	Embankment - Crest d/s of centerline and d/s face eroded behind right spillway wall. Abutment Slopes - None
Riprap	6-8 inch stone on u/s face. Sparse in some areas.
Instrumentation	None
Staff Gage	None
Miscellaneous	Trees and brush on u/s and d/s faces Construction for outlet works has exposed corewall.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS
Intake Structure	Original - Spillway weir New - Multi-level concrete intake tower.
Outlet Conduits	Original - 36" through spillway New - Two 30 inch diam. ductile iron pipes - one for pond drain; other water supply.
Gates	Original - Not observed; on upstream face of weir. In closed position. Controls rusted and in poor condition New - Sluice gates in intake structure - New
Outlet Structure	Original - D/S face spillway - No deficiencies New - Not constructed.
Outlet Channel	Spillway channel; see page A-5

SPILLWAY

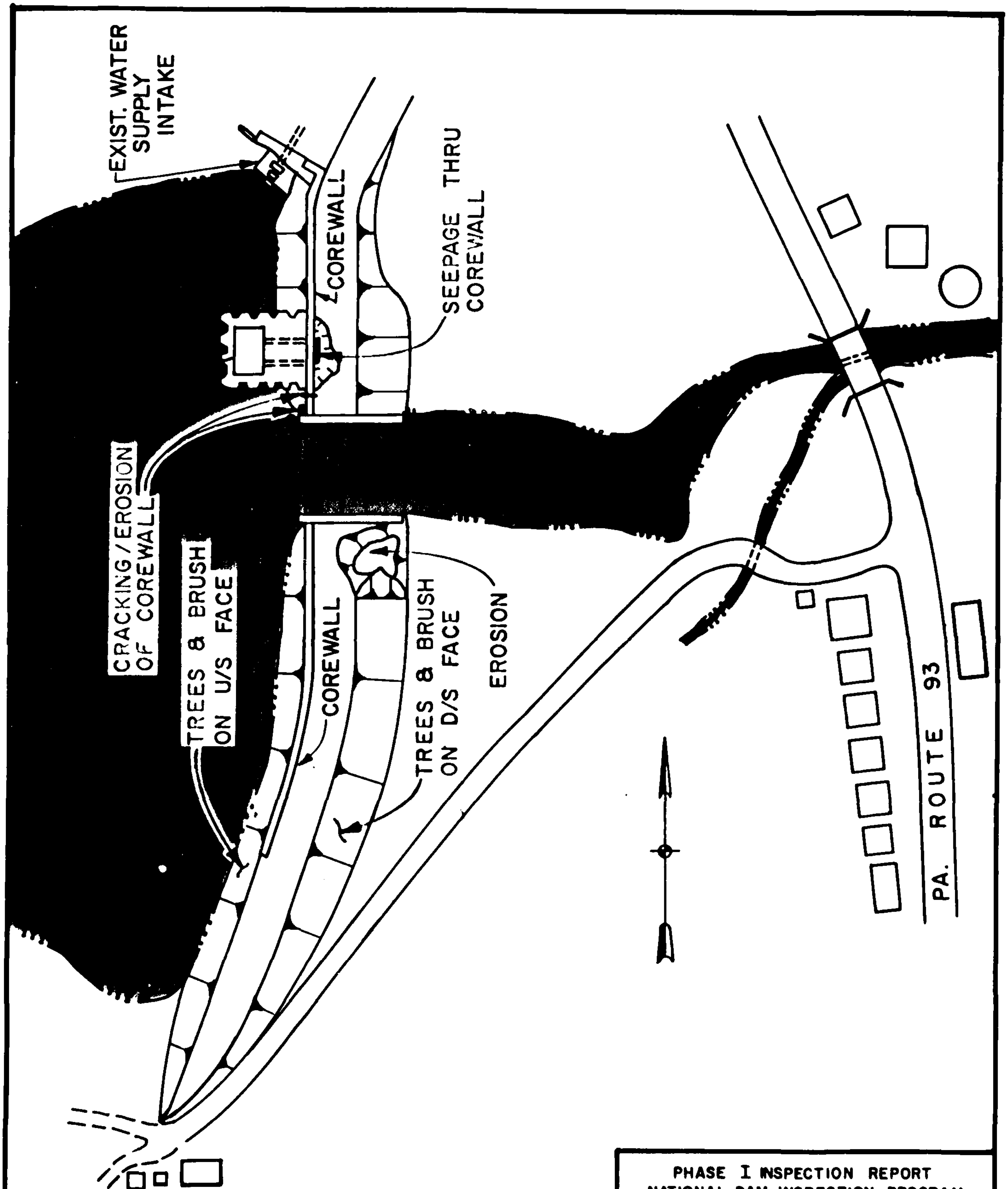
VISUAL EXAMINATION OF	OBSERVATIONS
Concrete Weir and Walls	Ogee with steel plates on crest - fair condition. Walls eroded along flow line;
Approach Channel	Reservoir; no obstructions
Discharge Channel	Former railroad bridge abutments for width of crest Large stone slabs in bottom; no problems. Earth & rock channel below - no erosion or obstructions.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS
Slopes	Wooded. Steep on left; flat on right. Appear stable.
Sedimentation	None observed.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS
Condition: obstructions	Earth and rock. Pa. Route 93 bridge 400 feet d/s. Joins Black Creek 2.3 miles downstream. No obstructions except Route 93 bridge.
Slopes	Flat for first 1,000 feet; then confined in relatively narrow steep sided valley.
Approximate Number of Homes	At least 3 homes less than 400 feet d/s on right flood plain.



NOT TO SCALE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

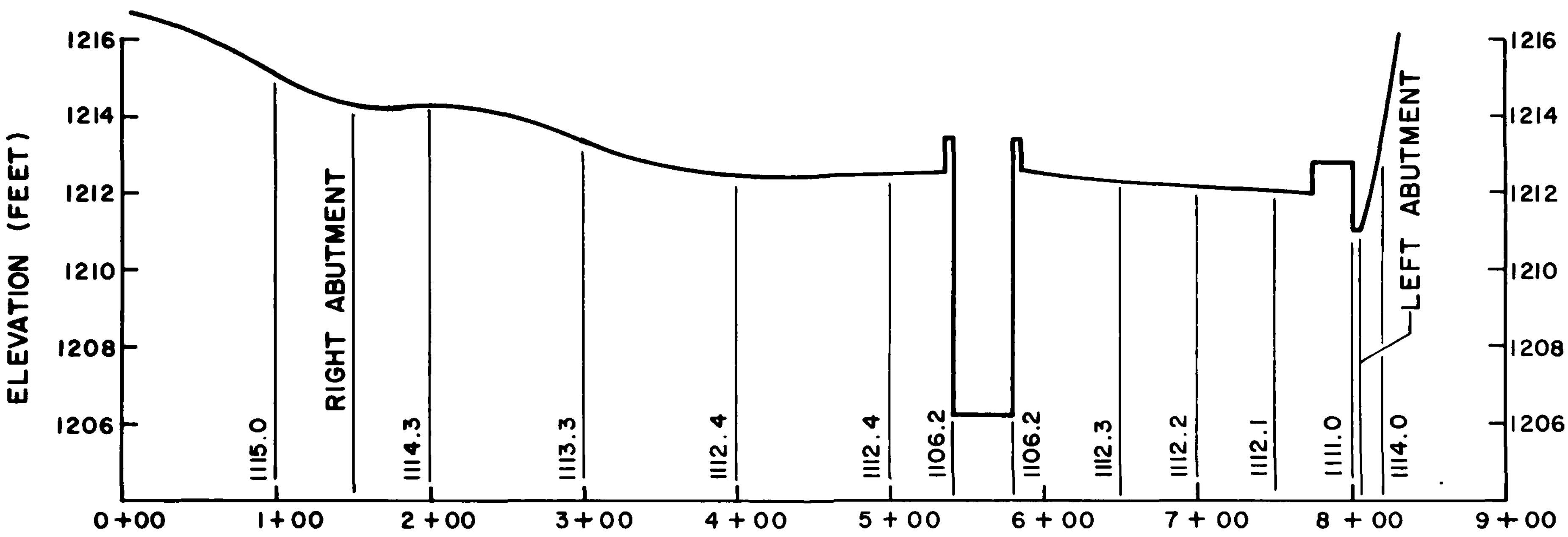
QUAKAKE DAM

HAZLETON CITY WATER AUTH.

FIELD SKETCH

MAY 1981

EXHIBIT A-1



TOP OF DAM – PROFILE

SCALE– HORIZ: 1 IN. = 100 FT.
VERT.: 1 IN. = 4 FT.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

QUAKAKE DAM

HAZLETON CITY WATER AUTH.

PROFILE

MAY 1981

EXHIBIT A-2

APPENDIX B

CHECKLIST - ENGINEERING DATA

APPENDIX B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE 1

NAME OF DAM QUAKAKE DAM
ID#

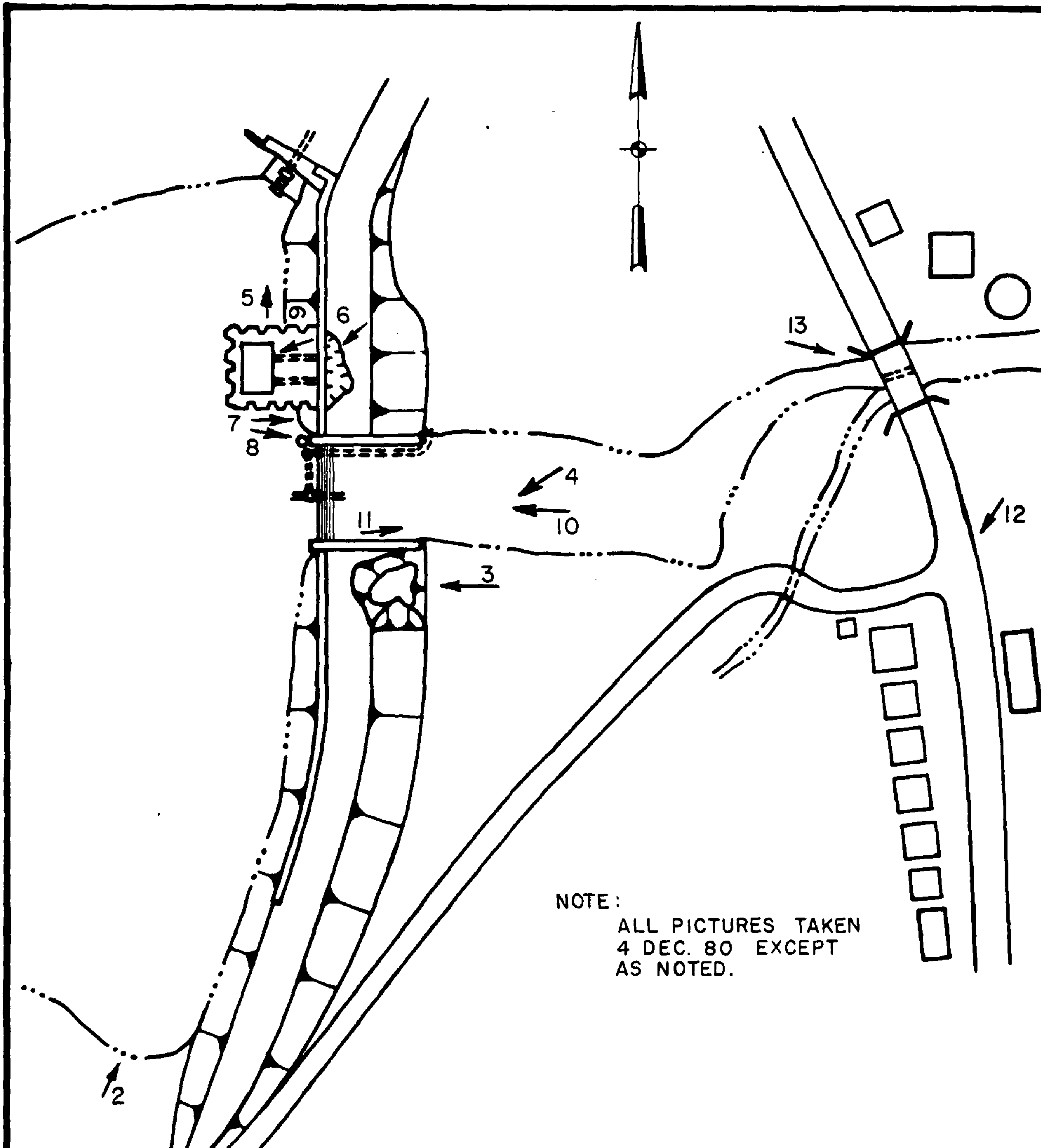
ITEM	REMARKS
AS-BUILT DRAWINGS	Sections and plan view
REGIONAL VICINITY MAP	U.S.G.S Weatherly Quadrangle 7.5 minute quad sheet See Appendix E. Plate E-2
CONSTRUCTION HISTORY	Earthfill structure with concrete corewall. Apparently constructed about 1897.
TYPICAL SECTIONS OF DAM	Sections shown on 1915 drawings.
OUTLETS - PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	Outlet data in 1915 PennDER report. New outlet and water supply structure is being constructed.
RAINFALL/RESERVOIR RECORDS	Unknown. Approximately 36 inches of water was reported passing the spillway in Aug. 33.
DESIGN REPORTS	None
GEOLOGY REPORTS	None

ITEM	REMARKS
DESIGN COMPUTATIONS HYDROLOGY & HYDRUALICS DAM STABILITY SEEPAGE STUDIES	No data. PennDER inspectors reported that the spillway is too small based on their calculations
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None
POST-CONSTRUCTION SURVEYS OF DAM	None reported.
BORROW SOURCES	No data
MONITORING SYSTEMS	None
MODIFICATIONS	None reported.
HIGH POOL RECORDS	Aug' 33 three feet of water over spillway
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATIONS RECORDS	Unknown
SPILLWAY PLAN SECTIONS DETAILS	Spillway section drawing.

OPERATING EQUIPMENT PLANS & DETAILS	No data.
SPECIFICATIONS	None.
MISCELLANEOUS	PennDER inspection reports.

APPENDIX C

PHOTOGRAPHS



LOCATION AND ORIENTATION OF CAMERA

3 PHOTOGRAPH IDENTIFICATION NUMBER

NOT TO SCALE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

QUAKAKE DAM

HAZLETON CITY WATER AUTH.

PHOTOGRAPH LOCATION PLAN

MAY 1981 EXHIBIT C-1

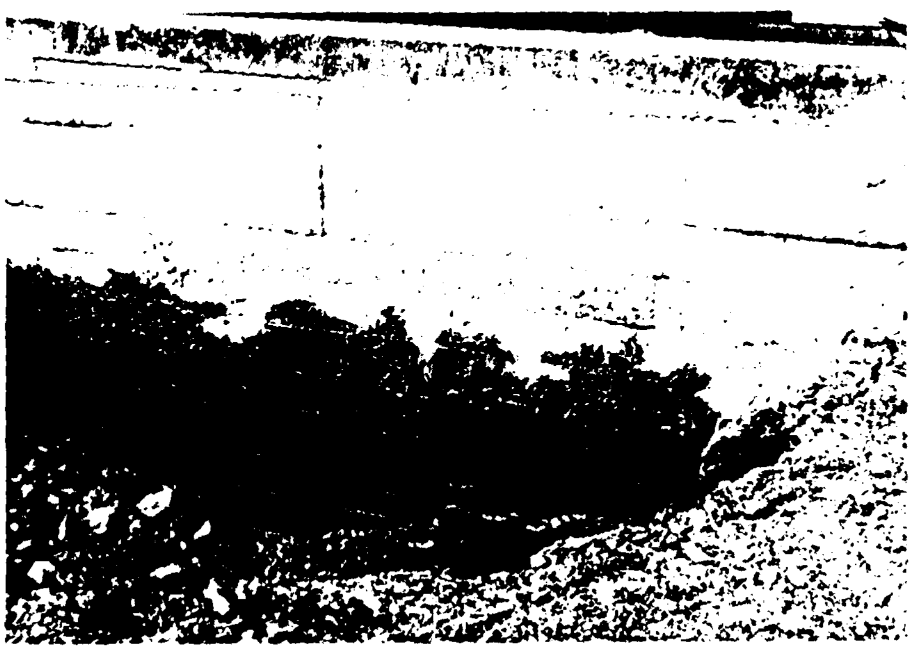
1. Crest near right abutment.

2. Upstream face of dam.

3. Erosion of crest behind right spillway wall.

4. Right spillway wall and eroded downstream face.

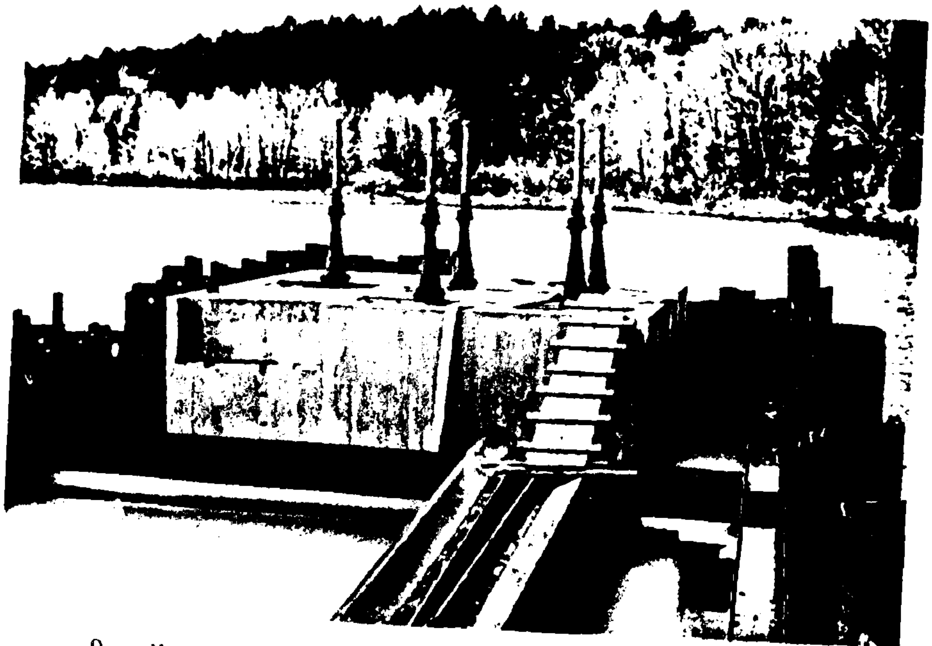
5. Upstream face and left abutment. Existing water supply intake structure.



6. Seepage through corewall (10 Mar 81).

7. Cracked corewall left of spillway.

8. Erosion and cracking of corewall left of spillway.

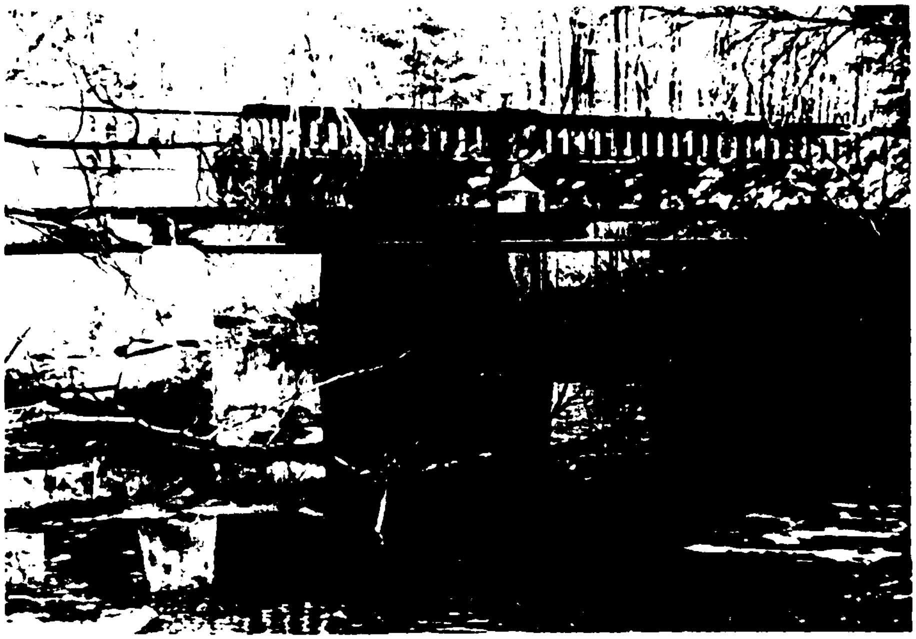


9. New water supply and pond drain intake structure (10 Mar 81)

10. Downstream face of spillway. Note existing outlet works in center of weir.

11. Spillway discharge channel.

12. Downstream residences in floodplain.
PA Route 93 in foreground.



13. First downstream obstruction (PA Route 93).

APPENDIX D

HYDROLOGY AND HYDRAULICS

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s), time(s) of the peak discharge(s), and the maximum stage(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequence resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevations of failure hydrographs for each location.

HYDROLOGY & HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: QUAKAKE DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.4 INCHES/24 HOURS (1)

SUSQUEHANNA RIVER BASIN

STATION	1	2	3
STATION DESCRIPTION	QUAKAKE DAM		
DRAINAGE AREA (SQUARE MILES)	17.2		
CUMULATIVE DRAINAGE AREA (SQUARE MILES)	17.2		
ADJUSTMENT OF PMF FOR (1) DRAINAGE AREA LOCATION (%)	HYDROMET ZONE 1		
6 Hours	105		
12 Hours	118		
24 Hours	128		
48 Hours	137		
72 Hours	—		
SNYDER HYDROGRAPH PARAMETERS			
Zone (2)	2		
C_p (3)	0.45		
C_t (3)	2.10		
L (MILES) (4)	10.15		
L_{ca} (MILES (4)	4.47		
$tp = C_t (L \cdot L_{ca})^{0.3}$ (HOURS)	6.60		
SPILLWAY DATA			
CREST LENGTH (FEET)	40		
FREEBOARD (FEET)	4.8		

(1) HYDROMETEOROLOGICAL REPORT - 33, U. S. Army Corps of Engineers, AND U.S. WEATHER BUREAU, 1956.

(2) Hydrologic zone defined by Corps of Engineers, Baltimore District, For Determination of Snyder Coefficients (C_p and C_t).

(3) Snyder Coefficients

(4) L = Length of longest watercourse from dam to basin divide.
L_{ca} = Length of longest watercourse from dam to point opposite basin centroid.

BALTIMORE DISTRICT, CORPS OF ENGINEERS PAGE

SUBJECT DAM SAFETY ANALYSIS

COMPUTATIONS QUAKAKE DAM SHEET 1 OF SHEETS

COMPUTED BY JPB CHECKED BY DATE 3-20-81

DAM CLASSIFICATION:

SIZE OF DAM : SMALL
HAZARD - HIGH
REQUIRED SDF - ½ PMF TO FULL PMF

DAM STATISTICS:

HEIGHT OF DAM - 15 FEET
STORAGE AT NORMAL POOL - 65 AC.-FT.
STORAGE AT TOP OF DAM - 140 AC.-FT.
DRAINAGE AREA ABOVE DAMSITE - 17.2 mi^2

ELEVATIONS:

TOP OF DAM LOW POINT (FEILD) - 1111.0
NORMAL POOL - 1106.2
STREAMBED AT CENTERLINE OF DAM - 1096.0
SPILLWAY CREST - 1106.2

HYDROGRAPH PARAMETERS:

RIVER BASIN - DELAWARE RIVER BASIN
ZONE - 2
SYNDERS COEFFICIENTS -

C_p - 0.45
C_t - 2.10

MEASURED PARAMETERS: *

L = LENGTH OF LONGEST WATERCOURSE, mi   L = 10.15mi
L_{CA} = LENGTH OF LONGEST WATERCOURSE TO CENTROID OF THE BASIN, mi L_{CA} = 4.47mi

* FROM U.S.G.S. QUAD SHEETS, 7½ MINUTE SERIES SCALE 1:2400.. WEATHERLY, HAZLETON, CONYNGHAM, TAMAQUE, DELANO, PA.

NABS FORM 1232, 28 MAR 74

BALTIMORE DISTRICT, CORPS OF ENGINEERS PAGE ______

SUBJECT: DAM SAFETY ANALYSIS

COMPUTATIONS: QUAKAKE DAM SHEET 2 OF ____ SHEETS

COMPUTED BY: JPB CHECKED BY: ______ DATE: 3-20-81

NOTE: ELEVATIONS ARE REFERENCED TO U.S.G.S. PLAQUE - 27E.W.S. (1942) ELEVATION 1110.41 AS FOUND ON DRAWINGS SHOWN IN APPENDIX E, PLATE E-8. THIS ELEVATION WILL BE THE DATUM FOR ALL ELEVATIONS IN THIS REPORT.

t_p = SYNDERS BASIN LAG TIME TO PEAK IN HOURS

$$t_p = C_t (L L_{CA})^{0.3} = 2.10(10.15(4.47))^{0.3} = 6.60$$

$$\therefore t_p = 6.60 \text{ hours}$$

RESERVOIR CAPACITY:

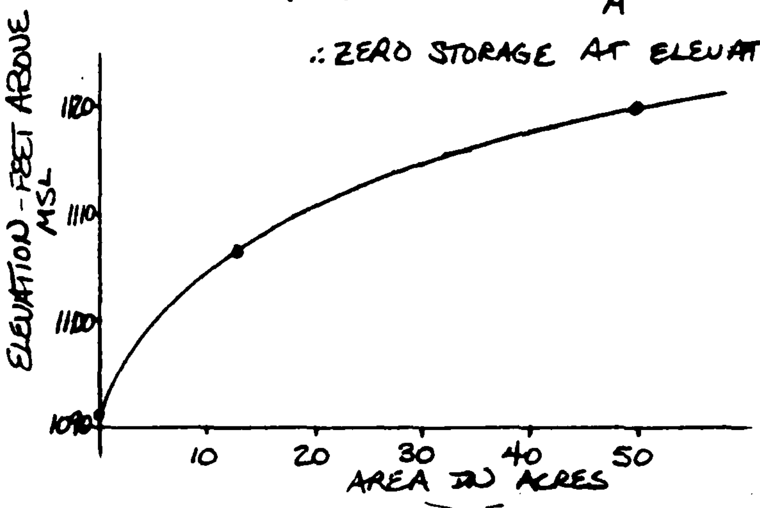
SURFACE AREA AT NORMAL POOL (1106.2) - 13 ACRES
SURFACE AREA AT ELEVATION 1120.0 - 50 ACRES

ASSUME CONICAL METHOD APPLIES TO FIND LOW POINT IN POOL, BELOW NORMAL POOL

VOLUME AT NORMAL POOL - 65 AC-FT
(FROM PENNDER FILES)

$$V = \tfrac{1}{3}AH \qquad H = \frac{3V}{A} = \frac{3(65 \text{ AC-FT})}{(13 \text{ ACRES})} = 15 \text{ FT}$$

$\therefore$ ZERO STORAGE AT ELEVATION 1091.2



FOR FLOOD ROUTING PURPOSE
ASSUME THE AVERAGE E
AREA METHOD IS SUITAE
TO ELEVATIONS ABOVE
NORMAL POOL ELEVAT
AND

$$\Delta V = \left(\frac{A_1 + A_2}{2}\right)\Delta H$$

BALTIMORE DISTRICT, CORPS OF ENGINEERS PAGE

SUBJECT: DAM SAFETY ANALYSIS

COMPUTATIONS: QUAKAKE DAM SHEET 3 OF SHEETS

COMPUTED BY: JPB CHECKED BY: DATE 3-21-81

ELEVATION STORAGE TABLE:

ELEVATION (MSL)	AREA (ACRES)	ΔH (ft)	$\Delta V = \left(\frac{A_1 + A_2}{2}\right)\Delta H$ (AC-FT)	CUMULATIVE VOLUME (AC-FT)
1091.2	0	–	–	0
1106.2	13	NORMAL POOL	65	65
1107.0	14	0.8	10.8	75.8
1108.0	15	1.0	14.5	90.3
1109.0	16.5	1.0	15.8	106.1
1110.0	18.0	1.0	17.3	123.4
1111.0 *	20.5	1.0	19.3	142.7
11112.0	23.0	2.0	43.5	186.2
1115.0	30.0	3.0	79.5	265.7
1120.0	50.0	5.0	200.0	465.7

*TOD = TOP OF DAM

NOTE: DRAINAGE AREA ABOVE DAM IS 17.2 mi². NOW ROUNDING TO NEAREST 10 AC-FT, THE FOLLOWING DATA WILL BE INPUT ON THE $S AND $E CARDS.

ELEVATION (MSL)	STORAGE (AC-FT)
1091.2	0
1106.2	65
1107.0	80
1108.0	90
1109.0	110
1110.0	120
1111.0	140
1112.0	190
1115.0	270
1120.0	470

NADB FORM 1232, 28 MAR 74

PMP CALCULATIONS:

- APPROXIMATE RAINFALL INDEX = 22.4 INCHES
  (CORRESPONDING TO A DURATION OF 24 HOURS AND A DRAINAGE AREA OF 200 mi^2) - ALL SEASON ENVELOPE
- DELAWARE RIVER BASIN
- DEPTH-AREA-DURATION ZONE 1 : FROM HYDROMET #33
- RECALL DRAINAGE AREA IS 17.2 mi^2

DURATION (HRS)	PERCENT OF INDEX RAINFALL
6	105
12	118
24	128
48	137

NOTE: HOP BROOK FACTOR IS INTERNALLY COMPUTED BY THE HEC1DB PROGRAM. FOR A DRAINAGE AREA OF 17.2 mi^2 THE ADJUSTMENT FACTOR = 0.818. THIS ADJUSTMENT IS FOR BASIN SHAPE AND FOR THE LESSER LIKLEHOOD OF A SEVERE STORM CENTERING OVER A SMALL BASIN.

SDF: BASED ON THE SMALL HEIGHT OF DAM (15 FEET) AND THE SMALL STORAGE AT LOW TOP OF DAM (LESS THAN 150 AC-FT) THE SDF SELECTED FOR THIS DAM IS 1/2 THE PROBABLE MAXIMUM FLOOD (PMF).

BALTIMORE DISTRICT, CORPS OF ENGINEERS PAGE ______

SUBJECT: DAM SAFETY ANALYSIS

COMPUTATIONS: QUAKAKE DAM SHEET 5 OF ______ SHEETS

COMPUTED BY: JPB CHECKED BY: ______ DATE: 3-21-81

EMERGENCY SPILLWAY CAPACITY:

SPILLWAY IS LOCATED APPROXIMATELY IN CENTER OF DAM. SEE FEILD SKETCH IN APPENDIX A, EXHIBIT 1.

SPILLWAY DATA:

TYPE - OGEE CREST WEIR, STEEL CAPPED
LENGTH - 40 FEET
CREST ELEVATION - 1106.2
LOW POINT TOP OF DAM - 1111.0
SPILLWAY FREEBOARD - 4.8 FEET

C VALUE: 3.40 FOR SPILLWAY CREST / FROM DER FILE SEEMS REASONABLE
2.85 FOR EMBANKMENT

SEE PHOTOGRAPHS IN APPENDIX C FOR SPILLWAY SECTION.

SPILLWAY RATING CURVE: $L = 40$ FEET, $C = 3.4$, $Q = CLH^{3/2}$

POOL ELEVATION (MSL)	HEAD (FEET)	Q CFS	ROUNDED Q (CFS)
1106.2	0	0	0
1107.0	0.8	97.3	100
1108.0	1.8	328	330
1109.0	2.8	637	640
1110.0	3.8	1007	1010
1111.0*	4.8	1431	1430
1112.0	5.8	1899	1900
1113.0	6.8	2411	2410
1114.0	7.8	2962	2960
1115.0	8.8	3550	3550
1120.0	13.8	6972	6970

* TOD = TOP OF DAM

NADB FORM 1232, 28 MAR 74

BALTIMORE DISTRICT, CORPS OF ENGINEERS PAGE

SUBJECT DAM SAFETY ANALYSIS

COMPUTATIONS QUAKAKE DAM SHEET 6 OF SHEETS

COMPUTED BY JPB CHECKED BY DATE 3-21-81

EMBANKMENT RATING CURVE:

THIS ANALYSIS ASSUMES THAT THE EMBANKMENT BEHAVES AS A BROAD CRESTED WEIR IF OVERTOPPING OCCURS. THIS DISCHARGE CAN BE ESTIMATED BY:

$$Q = CL_1 H_W^{3/2}$$

WHERE: Q = DISCHARGE OVER EMBANKMENT, IN CFS
L_1 = LENGTH OF EMBANKMENT, IN FEET.
H_W = WEIGHTED HEAD, IN FEET, AVERAGE FLOW AREA WEIGHTED ABOVE LOW POINT OF DAM
C = COEFFICIENT OF DISCHARGE

LENGTH OF EMBANKMENT INUNDATED VS. RESERVOIR ELEVATION:

RESERVOIR ELEVATION (MSL)	EMBANKMENT LENGTH (FEET)
1111.0	0
1112.0	15
1113.0	435
1114.0	520
1115.0	615 *
1120.0	615

* MAXIMUM LENGTH OF EMBANKMENT IS 615 FEET.

NADB FORM 1232, 28 MAR 74

BALTIMORE DISTRICT, CORPS OF ENGINEERS — PAGE ______

SUBJECT: DAM SAFETY ANALYSIS

COMPUTATIONS: QUAKAKE DAM — SHEET 7 OF ______ SHEETS

COMPUTED BY: JPB — CHECKED BY: ______ — DATE: 3-21-81

EMBANKMENT RATING TABLE:

RESERVOIR ELEVATION (MSL)	L_1 (FT)	L_2 (FT)	INCREMENTAL HEAD, H_i (FT)	① INCREMENTAL FLOW AREA, A_i (FT²)	TOTAL FLOW AREA, A_T (FT²)	② WEIGHTED HEAD, H_w (FT)	③ Q (CFS)
1111.0	0	–	0	0	0	0	0
1112.0	15	0	1.0	7.5	7.5	0.5	15
1113.0	435	15	1.0	225.0	232.5	0.54	491
1114.0	520	435	1.0	477.5	710.0	1.36	2350
1115.0	615	520	1.0	567.5	1277.5	2.08	5257
1120.0	615	615	5.0	3075.0	4352.5	7.08	33019

① $A_i = H_i((L_1+L_2)/2)$

② $H_w = A_T/L_1$

③ $Q = CL_1H_w^{3/2}$

RECALL C=2.85 FROM PAGE D-8 OF THIS APPENDIX.

TOTAL FACILITY RATING CURVE:

Ⓐ RESERVOIR ELEVATION (MSL)	Q SPILLWAY (CFS)	ROUNDED TO NEAREST 10 CFS Q EMBANKMENT (CFS)	Ⓑ Q TOTAL (CFS)
1106.2	0	0	0
1107.0	100	0	100
1109.0	640	0	640
1111.0	1430	0	1430
1112.0	1900	20	1920
1113.0	2410	490	2900
1114.0	2960	2350	5310
1115.0	3550	5260	8810
1120.0	6970	33020	39990

THE ABOVE VALUES Ⓐ & Ⓑ WILL BE INPUT ON Y4 & Y5 CARDS.

NADB FORM 1232, 28 MAR 74

BALTIMORE DISTRICT, CORPS OF ENGINEERS PAGE ______

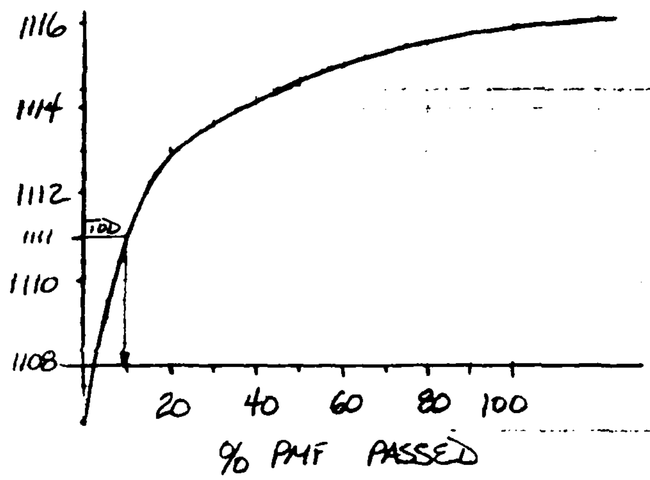
SUBJECT DAM SAFETY ANALYSIS

COMPUTATIONS QUAKAKE DAM SHEET 8 OF ______ SHEETS

COMPUTED BY JMB CHECKED BY ______ DATE 3-21-81

RESULTS OF OVERTOPPING ANALYSIS:

AS CAN BE FOUND FROM THE OVERTOPPING ANALYSIS, THE FOLLOWING CURVE CAN BE DRAWN FROM THE SUMMARY TABLE, ON PAGE D-21 OF THIS APPENDIX.



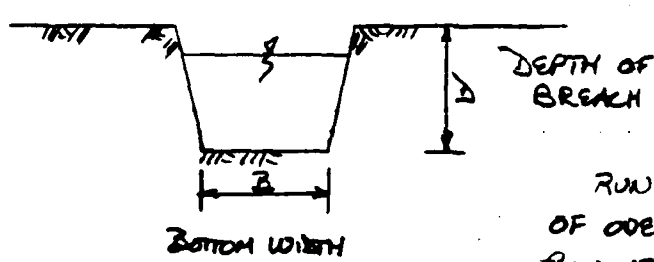
LAKE QUAKAKE DAM CAN PASS 9 % OF THE PMF PRIOR TO OVERTOPPING THE EMBANKMENT

TOD AT ELEV. 1111.0

THIS FACILITY CAN HANDLE 9% OF THE PMF. AT THE SDF (½ PMF), THE DAM IS OVERTOPPED TO A MAXIMUM HEIGHT OF 3.60 FEET FOR A TOTAL DURATION OF ~8.3 HOURS. SINCE IT IS FELT THAT AT 50% OF THE PMF THE DAM WOULD FAIL DUE TO OVERTOPPING, A BREACH ANALYSIS IS REQUIRED.

BREACH ANALYSIS:

TYPICAL BREACH SECTION



RUN BREACH AT ~0.5 FEET OF OVERTOPPING. THEREFORE, RUN 13% PMF TO BREACH.

NADB FORM 1232, 28 MAR 74

BALTIMORE DISTRICT, CORPS OF ENGINEERS PAGE ______

SUBJECT DAM SAFETY ANALYSIS

COMPUTATIONS QUAKAKE DAM SHEET 9 OF ______ SHEETS

COMPUTED BY JPB CHECKED BY ______ DATE 3-22-81

HEC1DB INPUT PARAMETERS FOR BREACH ANALYSIS

FOUR PLANS WILL BE USED FOR A DIRECT COMPARISON OF FAILURE VS. NON FAILURE CONDITIONS. PLAN 1 WILL BE A NON FAILURE PLAN, ALL OTHERS ARE FAILURE PLANS.

PLAN NUMBER	BREACH BOTTOM WIDTH (FT)	FULL BREACH DEPTH (FT)	SIDE SLOPES (H on V)	TOTAL BRK. TIME (H)
1	NON-FAILURE PLAN			
2	100	15	0.5 H on 1V	0.33
3	100	15	0.5 H on 1V	1.00
4	100	15	0.5 H on 1V	2.00

HEC1DB OUTPUT:

RESULTS OF BREACH ANALYSIS. AS NOTED ABOVE PLAN 1 IS A NON FAILURE PLAN FOR DIRECT COMPARISON.

PLAN NUMBER	MAXIMUM OUTFLOW OVER DAM AND/OR THRU BREACH (CFS)	DOWNSTREAM DAMAGE CENTER #1 STAGE (MSL)	DOWNSTREAM DAMAGE CENTER #1 FLOW (CFS)	DOWNSTREAM DAMAGE CENTER #2 STAGE (MSL)	DOWNSTREAM DAMAGE CENTER #2 FLOW (CFS)
1	1850	1098.0	1850	1096.2	1840
2	10200	1103.6	8630	1100.6	8500
3	4900	1101.3	4760	1098.7	4750
4	3520	1100.0	3370	1097.7	3370

DOWNSTREAM DAMAGE CENTER #1 - DAMAGE AT EL. 1101.0
DOWNSTREAM DAMAGE CENTER #2 - DAMAGE AT EL. 1101.0

NADB FORM 1232, 28 MAR 74

BALTIMORE DISTRICT, CORPS OF ENGINEERS PAGE ______

SUBJECT: DAM SAFETY ANALYSIS

COMPUTATIONS: QUAKAKE DAM SHEET 10 OF ______ SHEETS

COMPUTED BY: JPB CHECKED BY: ______ DATE: 4-2-81

OUTLET WORKS:

THE OLD OUTLET WORKS CONSISTS OF A 36 INCH DIAMETER CONDUIT THROUGH CENTER OF SPILLWAY WEIR. THE SLIDE GATE ON THE UPSTREAM FACE OF WEIR IS CLOSED AND APPEARS INOPERABLE.

CURRENTLY, A NEW OUTLET WORKS IS UNDER CONSTRUCTION. A MULTILEVEL INTAKE WITH SLIDE GATE CONTROLS ARE PROVIDED, AS THE STRUCTURE CAN EITHER DRAIN THE LAKE OR BE USED AS A WATER SUPPLY SOURCE. ONE OF THE TWO 30 INCH LINES WILL EXTENDED THRU THE SPILLWAY WALL.

THE FOLLOWING DATA WILL BE USED TO DETERMINE THE DISCHARGE CAPACITY AT MAXIMUM POOL, EL 1111.0.

INTAKE PORTAL SIZE -
30 INCH DIAMETER CONDUIT - DUCTILE IRON PIPE
ORIFICE EQUATION - $Q = CA\sqrt{2gh}$

INVERT OF INTAKE - 1098.0

$C = 0.6$

$A = \left(\frac{30\,in}{12\,in}\right)^2 \frac{\pi}{4} = 4.91\,ft^2$ $\qquad Q = 0.6(4.91)\sqrt{2(32.2)13}$

$g = 32.2\ ft/sec^2$

$h = 1111.0 - \text{INVERT OF INTAKE} = 13\text{ FEET}$

$\therefore Q = 85\text{ CFS}$

SEE APPENDIX E FOR MORE DETAILS OF NEW FACILITY.

NADB FORM 1232, 28 MAR 74

BALTIMORE DISTRICT, CORPS OF ENGINEERS PAGE

SUBJECT DAM SAFETY ANALYSIS

COMPUTATIONS QUAKAKE DAM SHEET 11 OF SHEETS

COMPUTED BY JTB CHECKED BY DATE 4-3-81

NOW, CHECK INLET CONTROL AND OUTLET CONTROL.

FOR INLET CONTROL, ASSUME CONCRETE PIPE CULVERT N VALUE IS VERY CLOSE TO DUCTILE IRON PIPE.

$D = 2.5$ ft $HW = 13$ FT $HW/D = 5.2$

$D = 30$ IN.

$\therefore Q = 88$ CFS.

OUTLET CONTROL, ASSUME TOP OF PIPE IS COVERED WITH FLOW OVER SPILLWAY.

PIPE INVERT IS 1097.91 ON OUTLET END

THEREFORE WATER SURFACE ELEV. IS 1100.41

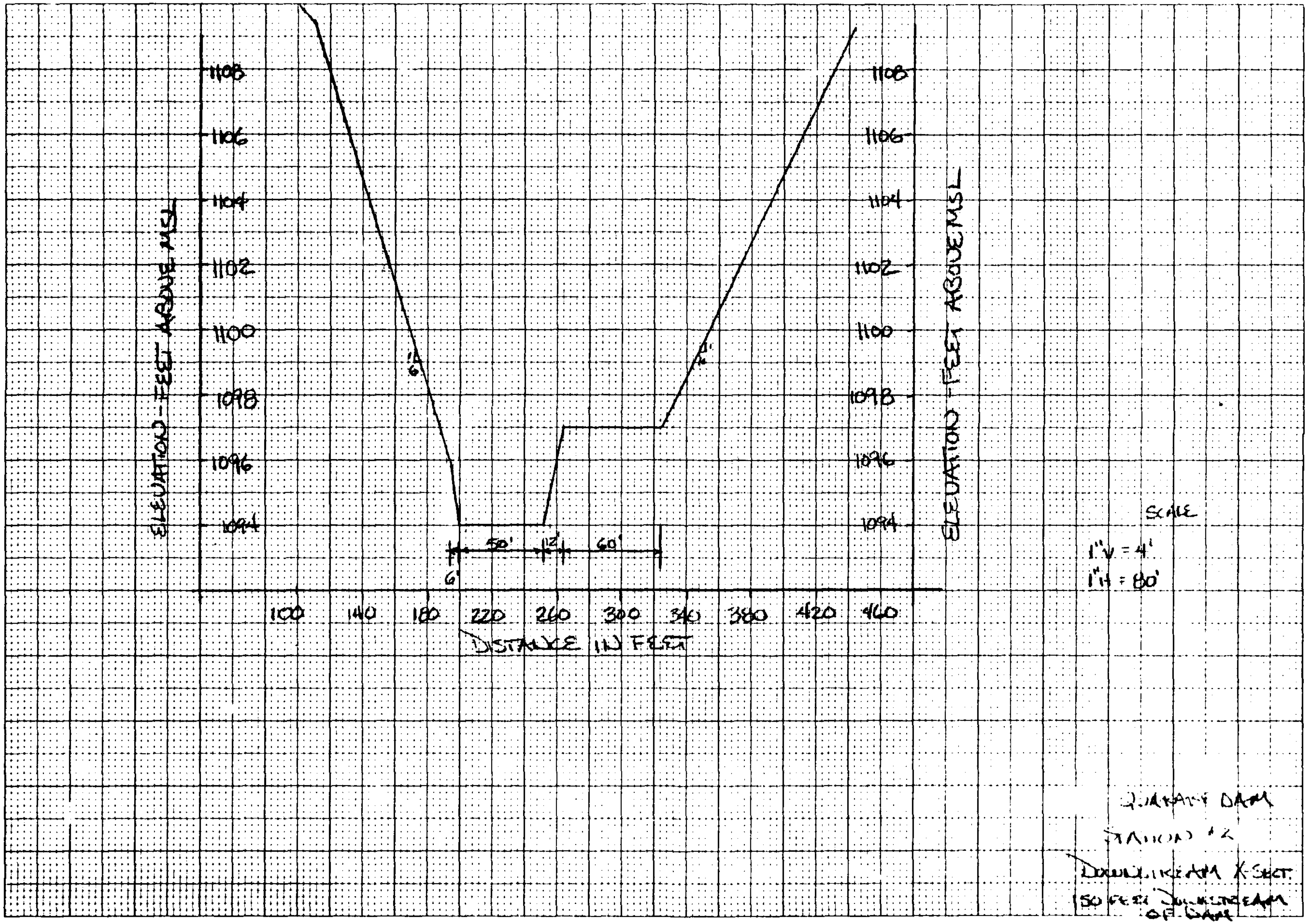
$\therefore H = 1111.0 - 1100.41 = \underline{10.59}$ $L \cong 110$ FEET

ASSUME $K_e = 0.5$

$Q = 85$ CFS

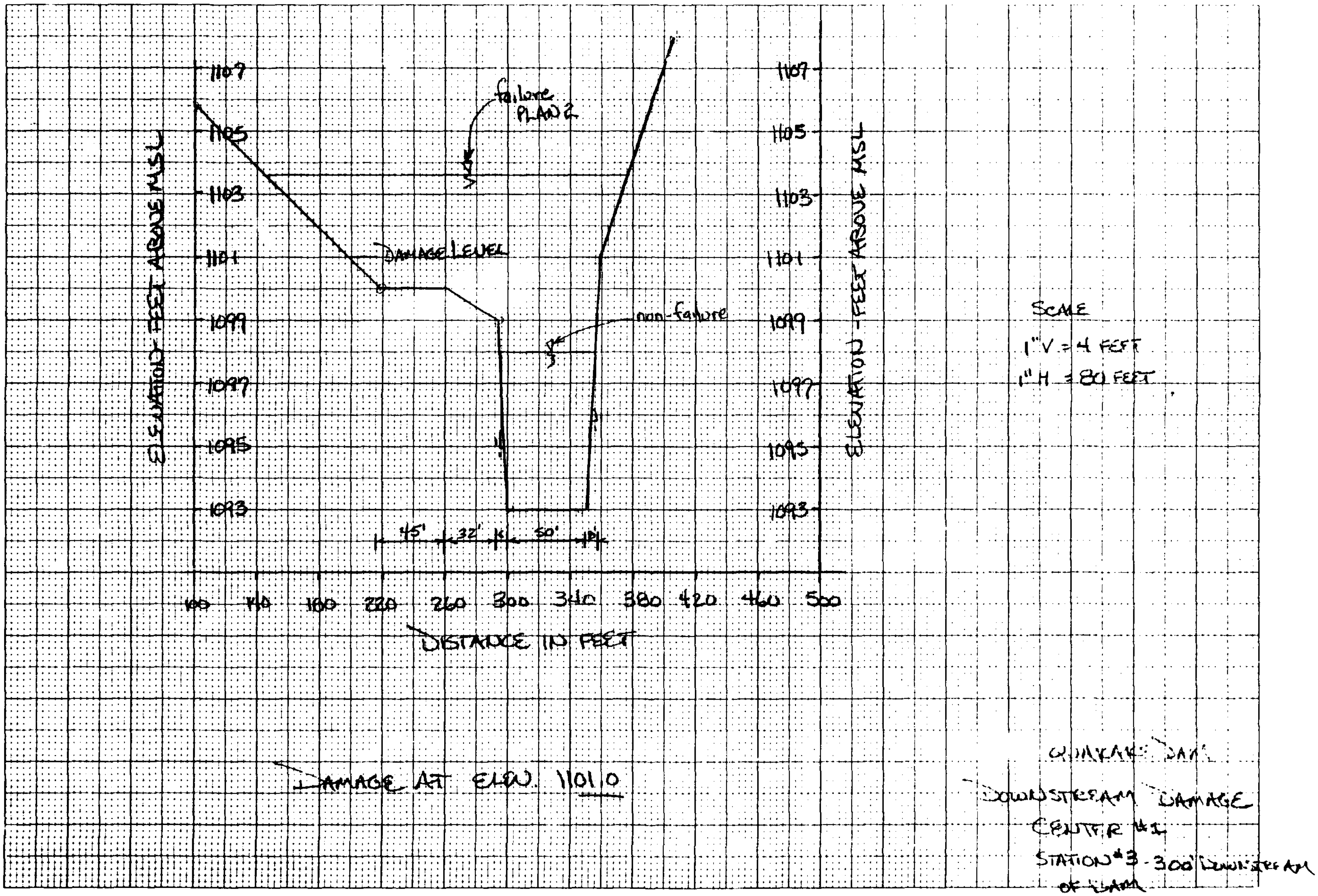
THEREFORE, USE 85 CFS AS DISCHARGE AT MAXIMUM POOL, ELEV 1111.0.

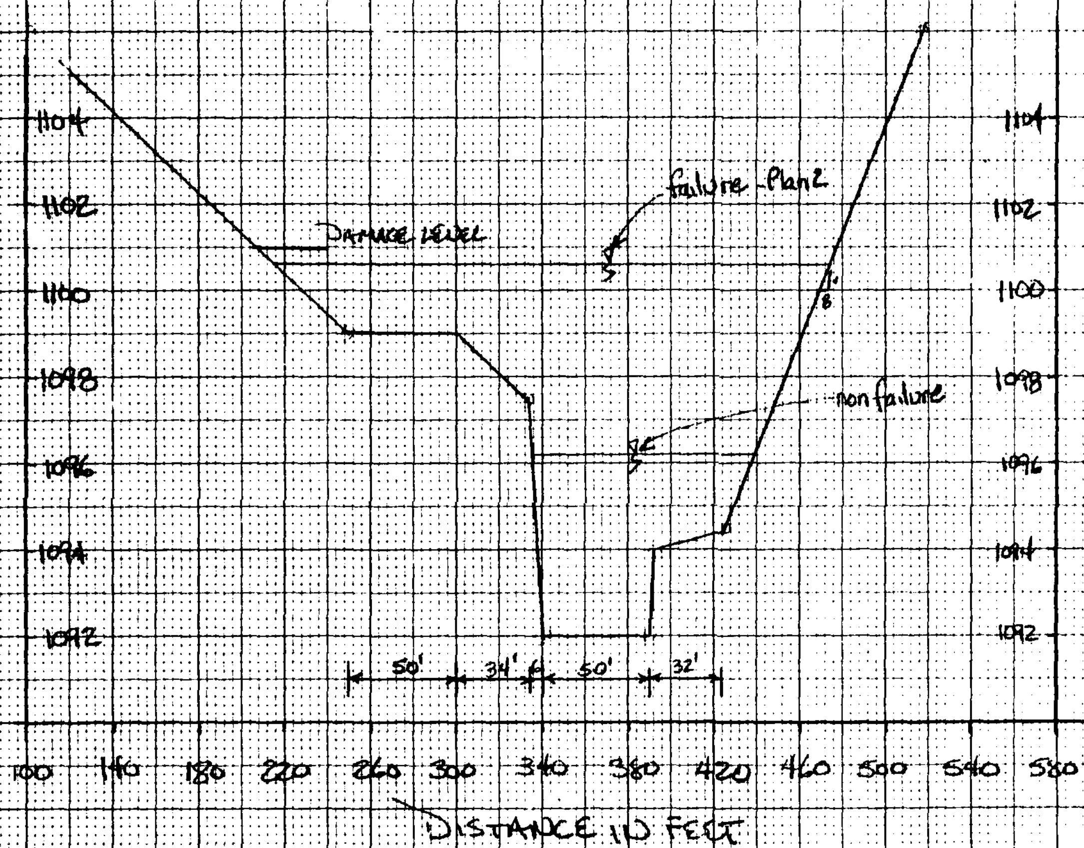
NADB FORM 1232, 28 MAR 74


ELEVATION - FEET ABOVE MSL
1108
1106
1104
1102
1100
1098
1096
1094
ELEVATION - FEET ABOVE MSL
1:6'
6'
50'
12'
60'
1:4'
100
140
180
220
260
300
340
380
420
460
DISTANCE IN FEET
SCALE
1" V = 4'
1" H = 80'
STATION #2
DOWNSTREAM X-SECT.
150 FEET DOWNSTREAM OF DAM

NO. 340-10', DIETZGEN GRAPH PAPER
10 X 10 PER HALF INCH

DIETZGEN CORPORATION
MADE IN U.S.A.





SCALE
1" V = 4 FEET
1" H = 80 FEET

QUAKAKE DAM
DOWNSTREAM DAMAGE
CENTER #2
STATION #4 400' DOWNSTREAM
OF DAM

DAMAGE AT ELEV. 1101.0

```
1*******************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
********************************
     1          A1     LAKE QUAKAKE DAM   DER NO. 90-13-11
     2          A2   DAM SAFTEY INSPECTION PROGRAM      3-21-81
     3          A3    OVERTOPPING ANALYSIS     ***  PRELIMINARY   ***
     4          B     144       0      20       0       0       0       0       0       0       0
     5          B1      5       0       0       0       0       0       0       0       0       0
     6          J       1       6       1
     7          J1   0.05    0.10    0.20    0.30    0.50    1.00
     8          K       0       1       0       0       0       0       1       0       0       0
     9          K1   RUNOFF FROM DRAINAGE AREA ABOVE LAKE QUAKAKE DAM
    10          M       1       1   17.20       0   17.20       0       0       0       1       0
    11          P       0    22.4     105     118     128     137
    12          T       0       0       0       0       0       0     1.0    0.05       0       0
    13          W    6.60    0.45
    14          X    -1.5   -0.05       2
    15          K       1       1       0       0       0       0       1       0       0       0
    16          K1   ROUTING %PMF'S THRU LAKE QUAKAKE DAM AND SPILLWAY
    17          Y       0       0       0       1       1       0       0       0       0       0
    18          Y1      1       0       0       0       0       0 -1106.2      -1       0       0
    19          Y41106.2  1107.0  1109.0  1111.0  1112.0  1113.0  1114.0  1115.0  1120.0
    20          Y5      0     100     640    1430    1920    2900    5310    8810   39990
    21          $S      0      65      80      90     110     120     140     190     270     470
    22          $E1091.2  1106.2  1107.0  1108.0  1109.0  1110.0  1111.0  1112.0  1115.0  1120.0
    23          $$1106.2
    24          $D1111.0
    25          K      99
1                     PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                RUNOFF HYDROGRAPH AT          1
                                ROUTE HYDROGRAPH TO           1
                                END OF NETWORK


1*******************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
********************************

RUN  DATE* 81/03/21.
     TIME* 08.25.31.
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QUAKAKE DAM

OVERTOPPING ANALYSIS

Page 1/4

LAKE QUAKAKE DAM   DER NO. 90-13-11
DAM SAFTEY INSPECTION PROGRAM   3-21-81
OVERTOPPING ANALYSIS   *** PRELIMINARY ***

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
144	0	20	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1
RTIOS= .05 .10 .20 .30 .50 1.00

********* ********* ********* ********* *********

SUB-AREA RUNOFF COMPUTATION

RUNOFF FROM DRAINAGE AREA ABOVE LAKE QUAKAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	17.20	0.00	17.20	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.40	105.00	118.00	128.00	137.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .818

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 6.60   CP= .45   NTA= 0

RECESSION DATA
STRTQ= -1.50   QRCSN= -.05   RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=20.42 AND R=31.63 INTERVALS

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 6.61 HOURS, CP= .45 VOL= .94

8.	30.	63.	102.	146.	195.	247.	302.	360.	420.
481.	539.	591.	638.	678.	713.	740.	761.	774.	778.
767.	745.	722.	700.	678.	657.	636.	617.	597.	579.
561.	543.	526.	510.	494.	479.	464.	449.	435.	422.
409.	396.	384.	372.	360.	349.	338.	328.	317.	308.
298.	289.	280.	271.	263.	254.	246.	239.	231.	224.
217.	210.	204.	198.	191.	185.	180.	174.	169.	163.
158.	153.	149.	144.	140.	135.	131.	127.	123.	119.
115.	112.	108.	105.	102.	99.	95.	92.	90.	87.
84.	82.	79.	77.	74.	72.	70.	67.	65.	63.

QUAKAKE DAM
OVERTOPPING ANALYSIS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING %PMF'S THRU LAKE QUAKAKE DAM AND SPILLWAY

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1106.	-1

STAGE	1106.20	1107.00	1109.00	1111.00	1112.00	1113.00	1114.00	1115.00	1120.0
FLOW	0.00	100.00	640.00	1430.00	1920.00	2900.00	5310.00	8810.00	39990.0

CAPACITY=	0.	65.	80.	90.	110.	120.	140.	190.	270.	470.
ELEVATION=	1091.	1106.	1107.	1108.	1109.	1110.	1111.	1112.	1115.	1120.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1106.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1111.0	0.0	0.0	0.

********* ********* ********* ********* *********

1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .05	RATIO 2 .10	RATIO 3 .20	RATIO 4 .30	RATIO 5 .50	RATIO 6 1.00
				RATIOS APPLIED TO FLOWS					
HYDROGRAPH AT	1	17.20	1	736.	1473.	2946.	4418.	7364.	14728.
	(	44.55)	(	20.85)(	41.71)(	83.41)(	125.12)(	208.53)(	417.06)(
ROUTED TO	1	17.20	1	734.	1447.	2947.	4417.	7364.	14730.
	(	44.55)	(	20.77)(	40.97)(	83.46)(	125.07)(	208.53)(	417.10)(

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1106.20	1106.20	1111.00
STORAGE	65.	65.	140.
OUTFLOW	0.	0.	1430.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	1109.24	0.00	112.	734.	0.00	46.33	0.00
.10	1111.03	.03	142.	1447.	1.67	46.67	0.00
.20	1113.02	2.02	217.	2947.	6.00	46.00	0.00
.30	1113.63	2.63	233.	4417.	7.33	46.00	0.00
.50	1114.59	3.59	259.	7364.	8.33	46.00	0.00
1.00	1115.95	4.95	308.	14730.	10.67	46.00	0.00

1******************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
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QUAKAKE DAM
OVERTOPPING ANAL.
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1*******************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
********************************
A1     LAKE QUAKAKE DAM   DER NO. 90-13-11
A2   DAM SAFTEY INSPECTION PROGRAM      3-21-81
A3    OVERTOPPING ANALYSIS    ***  PRELIMINARY   ***
B    144       0      20       0       0       0       0       0       0       0
B1     5       0       0       0       0       0       0       0       0       0
J      4       1       1
J1  0.13
K      0       1       0       0       0       0       1       0       0       0
K1   RUNOFF FROM DRAINAGE AREA ABOVE LAKE QUAKAKE DAM
M      1       1   17.20       0   17.20       0       0       0       1       0
P      0    22.4     105     118     128     137
T      0       0       0       0       0       0     1.0    0.05       0       0
W   6.60    0.45
X   -1.5   -0.05       2
K      1       1       0       0       0       0       1       0       0       0
K1   ROUTING %PMF'S THRU LAKE QUAKAKE DAM AND SPILLWAY
Y      0       0       0       1       1       0       0       0       0       0
Y1     1       0       0       0       0       0 -1106.2      -1       0       0
Y41106.2  1107.0  1109.0  1111.0  1112.0  1113.0  1114.0  1115.0  1120.0
Y5     0     100     640    1430    1920    2900    5310    8810   39990
$S     0      65      80      90     110     120     140     190     270     470
$E1091.2  1106.2  1107.0  1108.0  1109.0  1110.0  1111.0  1112.0  1115.0  1120.0
$$1106.2
$D1111.0
$B   100     0.5    1096    0.33  1106.2  1200.0
$B   100     0.5    1096    0.33  1106.2  1111.5
$B   100     0.5    1096    1.00  1106.2  1111.5
$B   100     0.5    1096    2.00  1106.2  1111.5
K      1       2       0       0       0       0       1
K1  ROUTE FLOWS THRU FIRST DOWNSTREAM CROSS SECTION
Y      0       0       0       1       1
Y1     1       0
Y6  0.07    0.05    0.07    1094    1110     150    0.01
Y7   100    1110     156    1102     186    1096     200    1094     250    1094
Y7   264    1097     324    1097     452    1110
K      1       3       0       0       0       0       1
K1   ROUTE FLOWS THRU  FIRST DOWNSTREAM DAMAGE CENTER***
Y      0       0       0       1       1
Y1     1       0
Y6  0.07    0.05    0.07    1093    1109     150   0.007
Y7    40    1109     220    1100     294    1099     300    1093     350    1093
Y7   360    1101     380    1104     416    1109
K      1       4       0       0       0       0       1
K1   ROUTE FLOWS THRU 2ND DOWNSTREAM DAMAGE CENTER******
Y    . 0       0       0       1       1
Y1     1
Y6  0.07    0.05    0.07    1092    1106     100    0.01
Y7   100    1106     250    1099     332    1097     340    1092     390    1092
Y7   392    1094     422    1095     516    1106
K     99
```

QUAKAKE LAKE

BREACH ANALYSIS
Page 1/8

1 PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 1
ROUTE HYDROGRAPH TO 1
ROUTE HYDROGRAPH TO 2
ROUTE HYDROGRAPH TO 3
ROUTE HYDROGRAPH TO 4
END OF NETWORK

1******************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
100.	.50	1096.00	.33	1106.20	1200.00

PEAK OUTFLOW IS 1844. AT TIME 47.00 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
100.	.50	1096.00	.33	1106.20	1111.50

BEGIN DAM FAILURE AT 45.33 HOURS

PEAK OUTFLOW IS 10136. AT TIME 45.63 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
100.	.50	1096.00	1.00	1106.20	1111.50

BEGIN DAM FAILURE AT 45.33 HOURS

PEAK OUTFLOW IS 4914. AT TIME 46.04 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
100.	.50	1096.00	2.00	1106.20	1111.50

BEGIN DAM FAILURE AT 45.33 HOURS

PEAK OUTFLOW IS 3517. AT TIME 46.29 HOURS

QUAKAKE LAKE
BREACH ANALYSIS
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********* ********* ********* ********* *********

HYDROGRAPH ROUTING

ROUTE FLOWS THRU FIRST DOWNSTREAM CROSS SECTION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0700	.0500	.0700	1094.0	1110.0	150.	.01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
100.00 1110.00 156.00 1102.00 186.00 1096.00 200.00 1094.00 250.00 1094.00
264.00 1097.00 324.00 1097.00 452.00 1110.00

STORAGE	0.00	.16	.35	.56	.88	1.33	1.81	2.33	2.89	3.48
	4.12	4.79	5.50	6.25	7.05	7.88	8.76	9.68	10.64	11.64
OUTFLOW	0.00	115.87	382.97	803.53	1413.00	2316.26	3466.72	4853.03	6472.40	8325.46
	10408.12	12728.10	15298.47	18125.12	21214.21	24572.08	28205.13	32119.84	36322.68	40820.13
STAGE	1094.00	1094.84	1095.68	1096.53	1097.37	1098.21	1099.05	1099.89	1100.74	1101.58
	1102.42	1103.26	1104.11	1104.95	1105.79	1106.63	1107.47	1108.32	1109.16	1110.00
FLOW	0.00	115.87	382.97	803.53	1413.00	2316.26	3466.72	4853.03	6472.40	8325.46
	10408.12	12728.10	15298.47	18125.12	21214.21	24572.08	28205.13	32119.84	36322.68	40820.13

QUAKAKE LAKE
BREACH ANALYSIS
page 3/8

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE FLOWS THRU FIRST DOWNSTREAM DAMAGE CENTER***

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0700	.0500	.0700	1093.0	1109.0	150.	.00700

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
40.00 1109.00 220.00 1100.00 294.00 1099.00 300.00 1093.00 350.00 1093.00
360.00 1101.00 380.00 1104.00 416.00 1109.00

STORAGE	0.00	.15	.30	.46	.62	.79	.97	1.15	1.40	1.81
	2.28	2.80	3.40	4.06	4.78	5.57	6.43	7.36	8.35	9.40
OUTFLOW	0.00	93.45	296.47	582.79	942.15	1368.69	1858.66	2409.54	3064.62	3892.68
	4927.35	6172.52	7615.16	9267.49	11141.06	13249.42	15604.81	18219.12	21103.95	24270.67
STAGE	1093.00	1093.84	1094.68	1095.53	1096.37	1097.21	1098.05	1098.89	1099.74	1100.58
	1101.42	1102.26	1103.11	1103.95	1104.79	1105.63	1106.47	1107.32	1108.16	1109.00
FLOW	0.00	93.45	296.47	582.79	942.15	1368.69	1858.66	2409.54	3064.62	3892.68
	4927.35	61[illegible]52	7615.16	9267.49	11141.06	13249.42	15604.81	18219.12	21103.95	24270.67

QUAKAKE DAM
BREACH ANALYSIS
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********* ********* ********* ********* *********

HYDROGRAPH ROUTING

ROUTE FLOWS THRU 2ND DOWNSTREAM DAMAGE CENTER******

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0700	.0500	.0700	1092.0	1106.0	100.	.01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
100.00 1106.00 250.00 1099.00 332.00 1097.00 340.00 1092.00 390.00 1092.00
392.00 1094.00 422.00 1095.00 516.00 1106.00

STORAGE	0.00	.09	.18	.27	.39	.55	.71	.89	1.12	1.40
	1.75	2.13	2.56	3.02	3.52	4.05	4.63	5.24	5.88	6.57
OUTFLOW	0.00	89.56	284.57	562.30	933.76	1420.34	2013.38	2717.88	3575.91	4603.56
	5841.25	7300.81	8979.12	10885.42	13029.55	15421.53	18071.38	20989.04	24184.34	27666.97
STAGE	1092.00	1092.74	1093.47	1094.21	1094.95	1095.68	1096.42	1097.16	1097.89	1098.63
	1099.37	1100.11	1100.84	1101.58	1102.32	1103.05	1103.79	1104.53	1105.26	1106.00
FLOW	0.00	89.56	284.57	562.30	933.76	1420.34	2013.38	2717.88	3575.91	4603.56
	5841.25	7300.81	8979.12	10885.42	13029.55	15421.53	18071.38	20989.04	24184.34	27666.97

QUAKAKE DAM
BREACH ANALYSIS
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1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1 .13
HYDROGRAPH AT	1	17.20	1	1915.
	(	44.55)	(	54.22)(
			2	1915.
			(	54.22)(
			3	1915.
			(	54.22)(
			4	1915.
			(	54.22)(
ROUTED TO	1	17.20	1	1844.
	(	44.55)	(	52.21)(
			2	9026.
			(	255.58)(
			3	4794.
			(	135.76)(
			4	3369.
			(	95.40)(
ROUTED TO	2	17.20	1	1843.
	(	44.55)	(	52.18)(
			2	8836.
			(	250.20)(
			3	4787.
			(	135.55)(
			4	3372.
			(	95.49)(
ROUTED TO	3	17.20	1	1843.
	(	44.55)	(	52.18)(
			2	8626.
			(	244.27)(
			3	4759.
			(	134.75)(
			4	3372.
			(	95.49)(
ROUTED TO	4.	17.20	1	1843.
	(	44.55)	(	52.18)(
			2	8496.
			(	240.57)(
			3	4745.
			(	134.38)(
			4	3374.
			(	95.53)(

QUAKAKE DAM
BREACH ANALYSIS
Page 6/8

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1106.20	1106.20	1111.00
STORAGE	65.	65.	140.
OUTFLOW	0.	0.	1430.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.13	1111.84	.84	182.	1844.	4.67	47.00	0.00

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1106.20	1106.20	1111.00
STORAGE	65.	65.	140.
OUTFLOW	0.	0.	1430.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.13	1111.59	.59	169.	10136.	2.21	45.63	45.33

PLAN 3 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1106.20	1106.20	1111.00
STORAGE	65.	66.	140.
OUTFLOW	0.	0.	1430.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.13	1111.60	.60	170.	4914.	2.47	46.04	45.33

PLAN 4 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1106.20	1106.20	1111.00
STORAGE	65.	66.	140.
OUTFLOW	0.	0.	1430.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.13	1111.63	.63	171.	3517.	2.79	46.29	45.33

QUAKAKE DAM
BREACH ANALYSIS
page 7/8

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	1843.	1097.8	47.00

PLAN 2 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	8836.	1101.8	45.67

PLAN 3 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	4787.	1099.9	46.00

PLAN 4 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	3372.	1099.0	46.33

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	1843.	1098.0	47.00

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	8626.	1103.6	45.67

PLAN 3 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	4759.	1101.3	46.00

PLAN 4 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	3372.	1100.0	46.33

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	1843.	1096.2	47.00

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	8496.	1100.6	45.67

PLAN 3 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	4745.	1098.7	46.00

PLAN 4 STATION 4

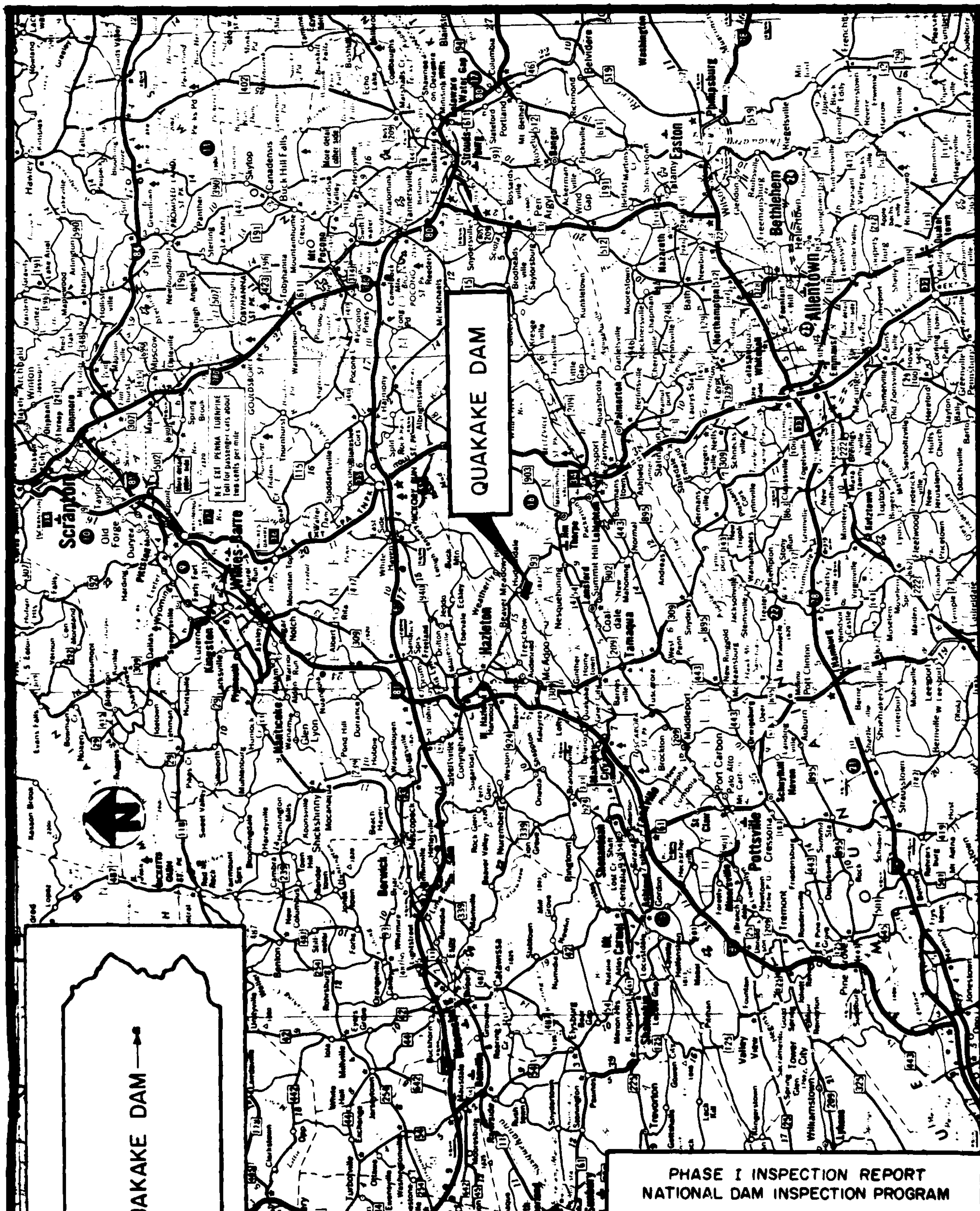
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.13	3374.	1097.7	46.33

1**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

QUAKAKE DAM
BREACH ANALYSIS
Page 8/8

APPENDIX E

PLATES



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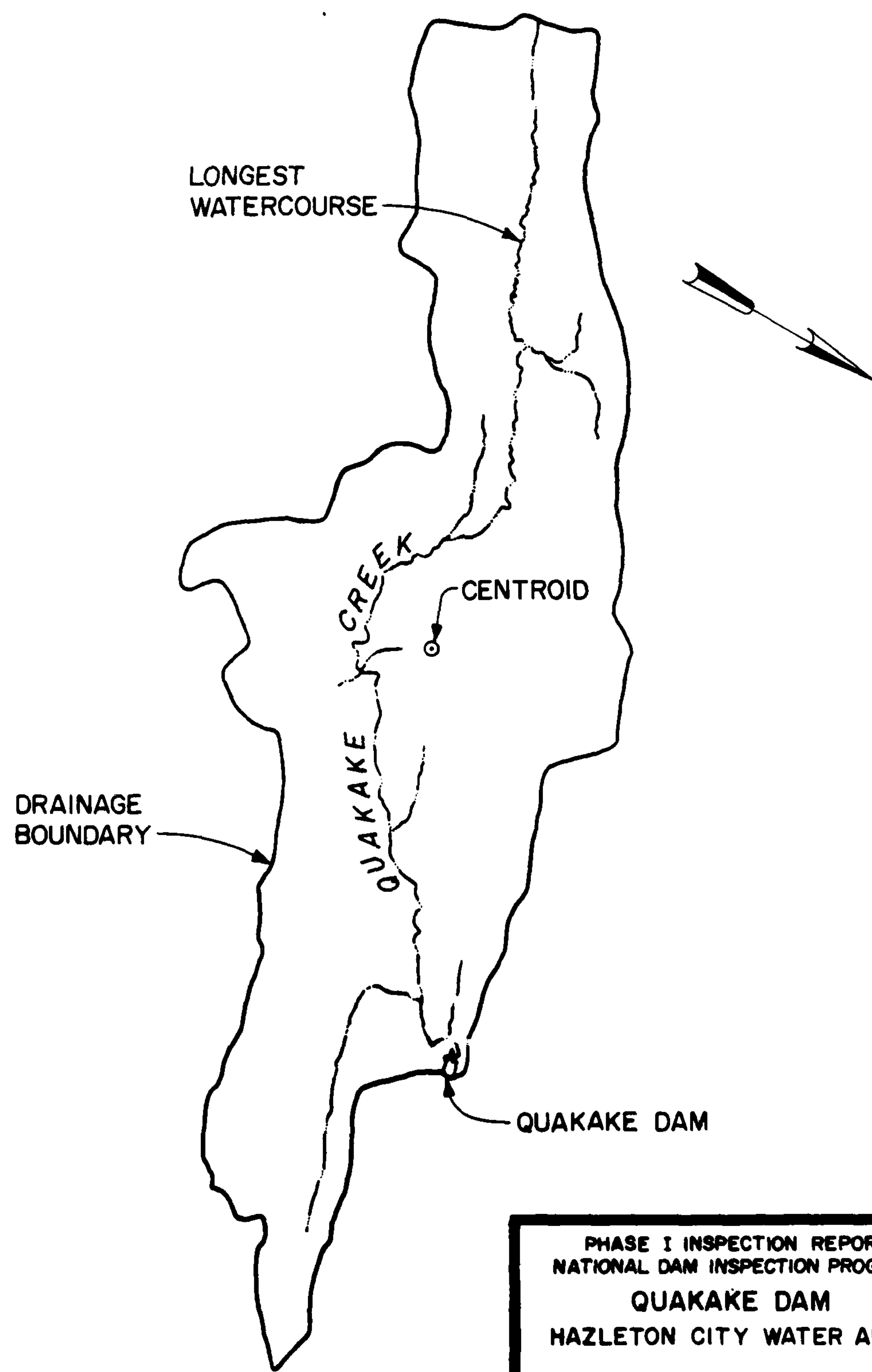
NATIONAL DAM INSPECTION PROGRAM

QUAKAKE DAM

HAZLETON CITY WATER AUTH.

LOCATION MAP

MAY 1981 PLATE E-I



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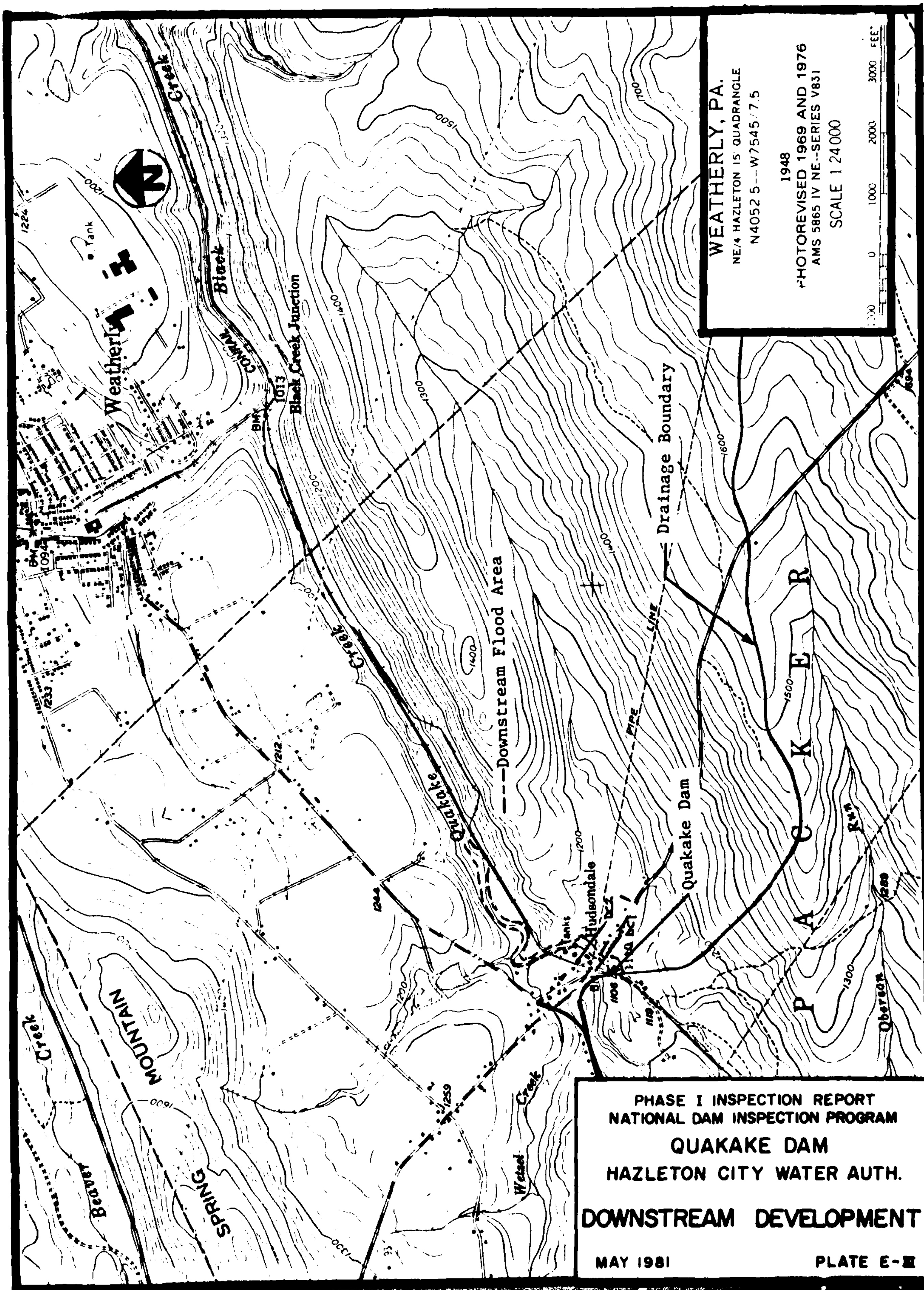
NATIONAL DAM INSPECTION PROGRAM

QUAKAKE DAM

HAZLETON CITY WATER AUTH.

DRAINAGE AREA PLAN

MAY 1981 PLATE E-II



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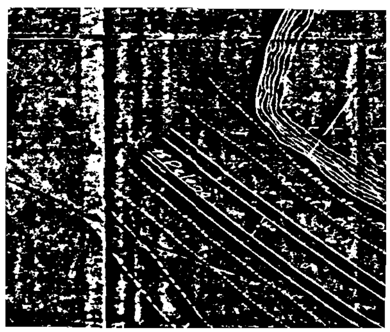
QUAKAKE DAM

HAZLETON CITY WATER AUTH.

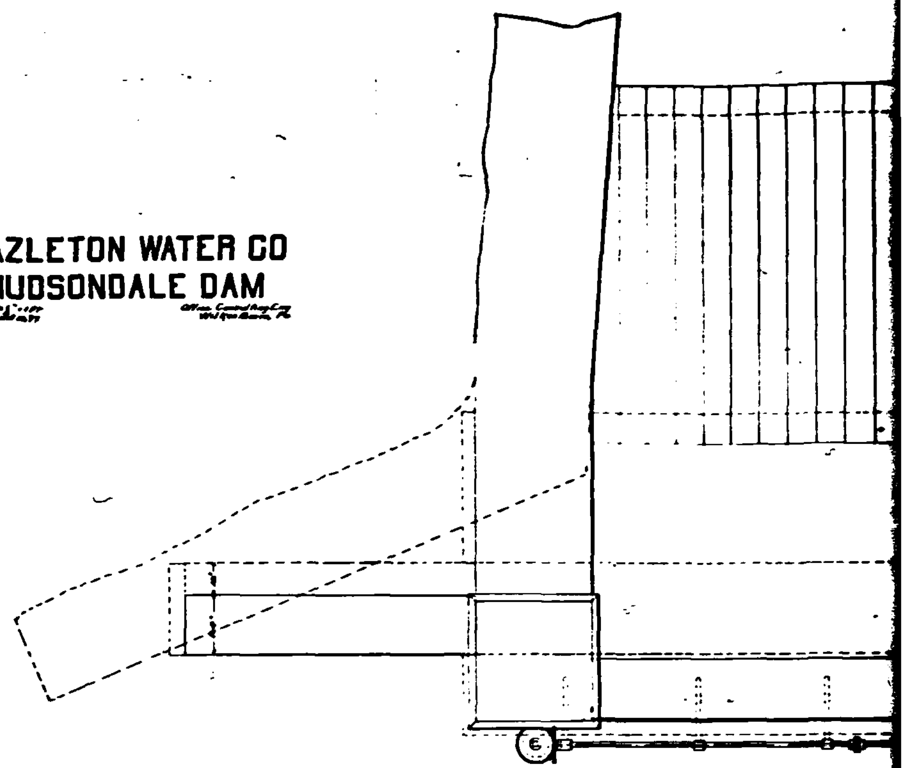
DOWNSTREAM DEVELOPMENT

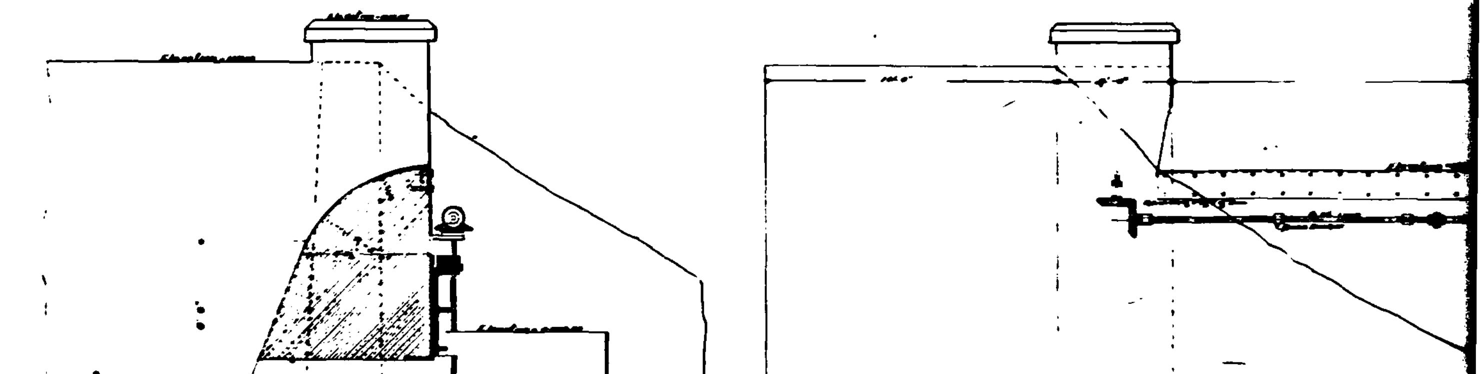
MAY 1981

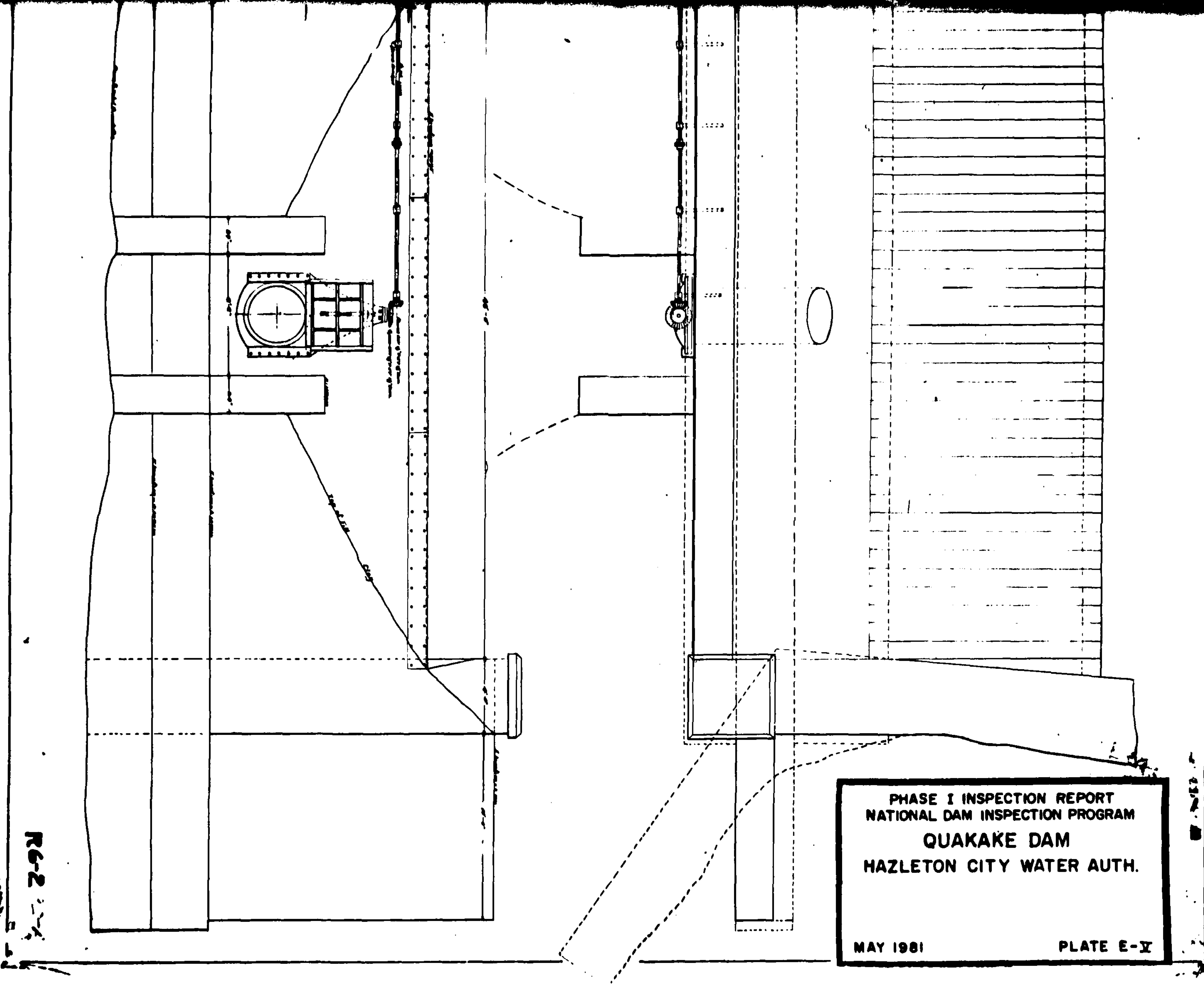
PLATE E-II



HAZLETON WATER CO
HUDSONDALE DAM







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NATIONAL DAM INSPECTION PROGRAM

QUAKAKE DAM

HAZLETON CITY WATER AUTH.

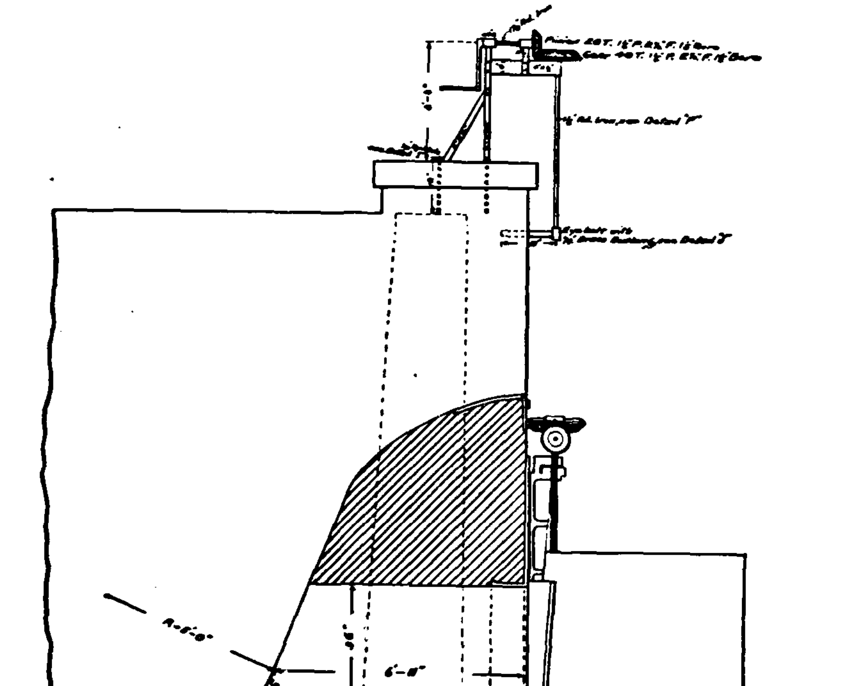
MAY 1981

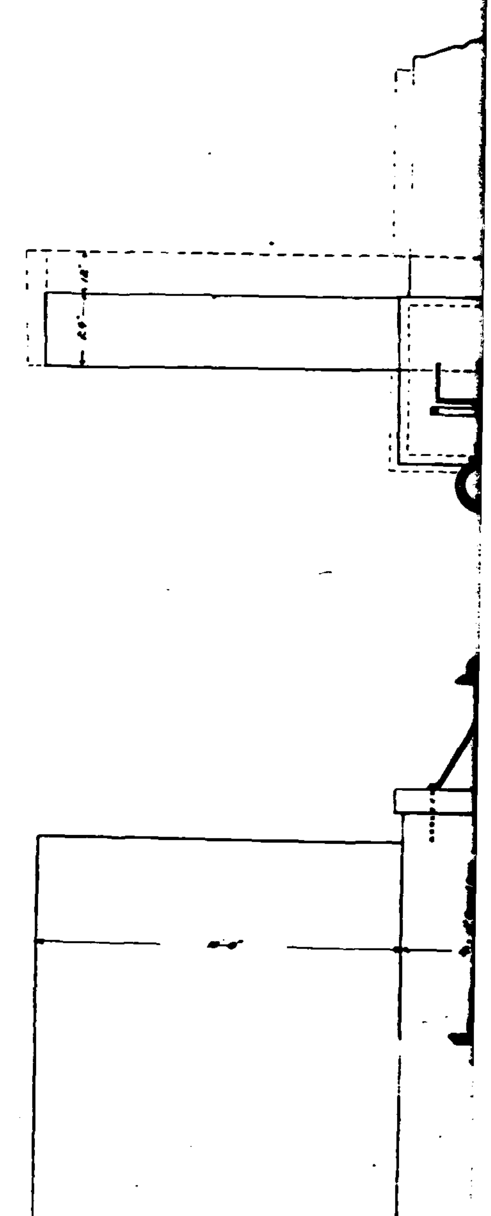
PLATE E-V

HAZLETON WATER CO.
HUDSONDALE DAM

Scale ¼" = 1 Ft.
Septem. 5-08

Eng. Dep. L.V.C.Co.
Lehigh Div.

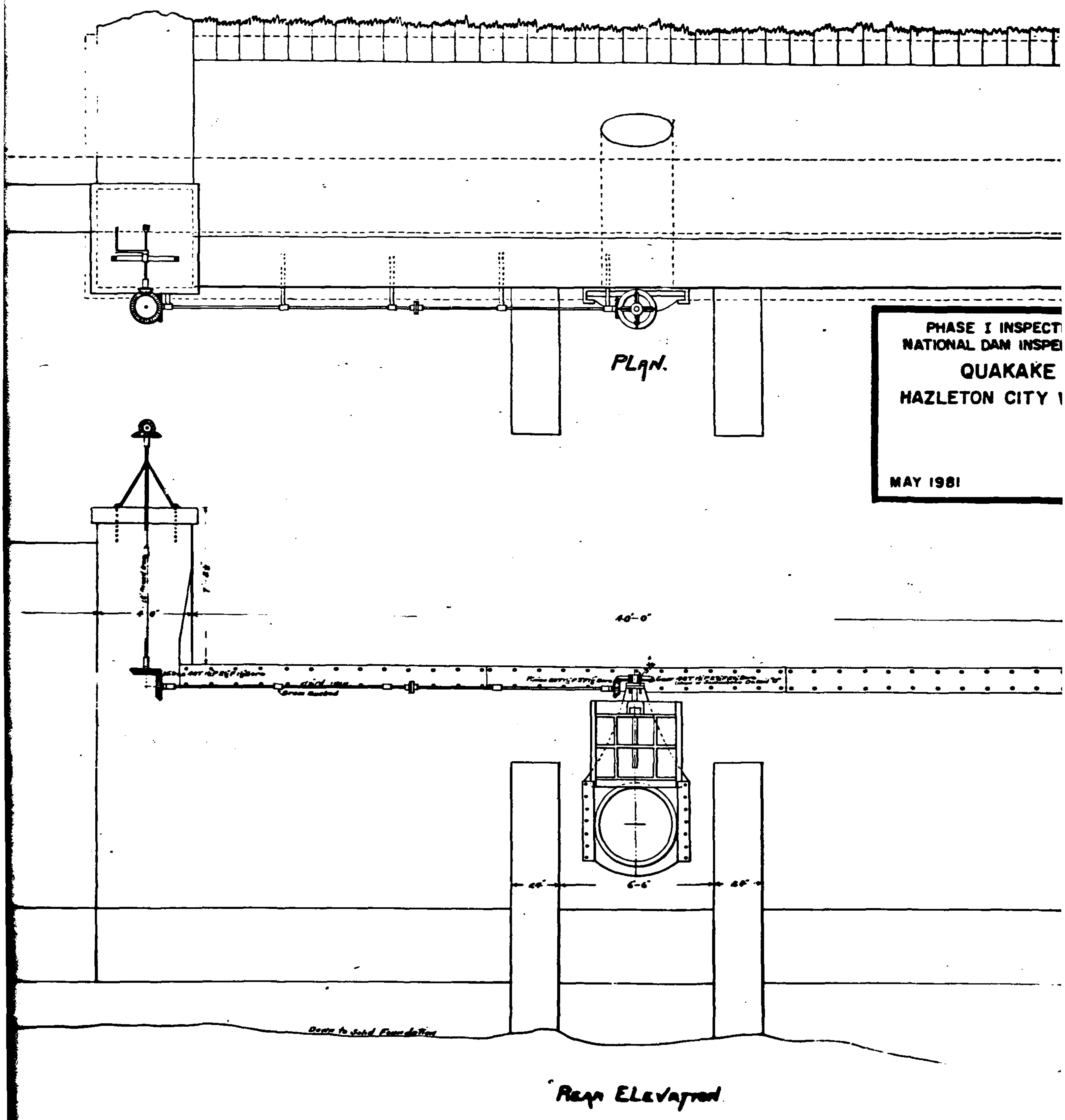




B-7

MID SECTION,

and auto-operating Gear on East Abutment.



PHASE I INSPECTI
NATIONAL DAM INSPE
QUAKAKE
HAZLETON CITY
MAY 1981

AD-A101 270 CORPS OF ENGINEERS BALTIMORE MD BALTIMORE DISTRICT F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. QUAKAKE DAM (NDI ID NUMBER PA---ETC(U)
APR 81

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2 of 2
AD A
101 270

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8-81
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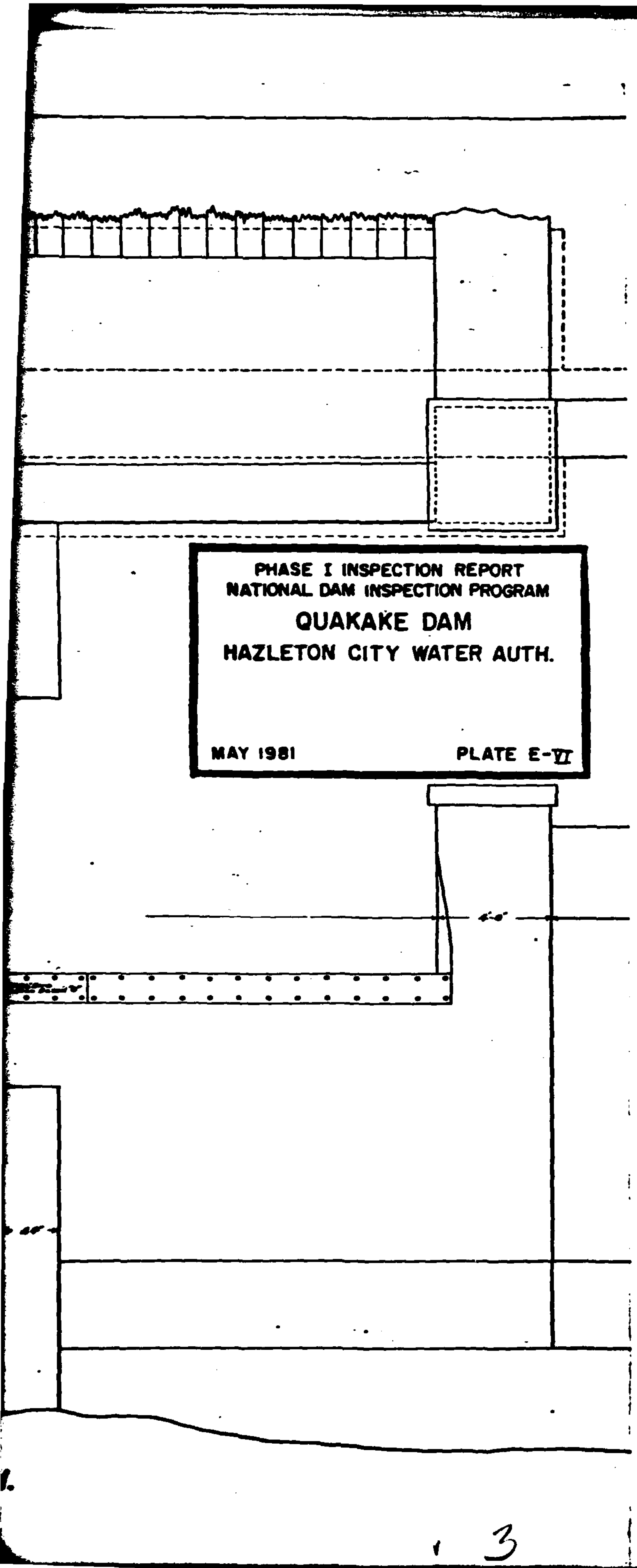
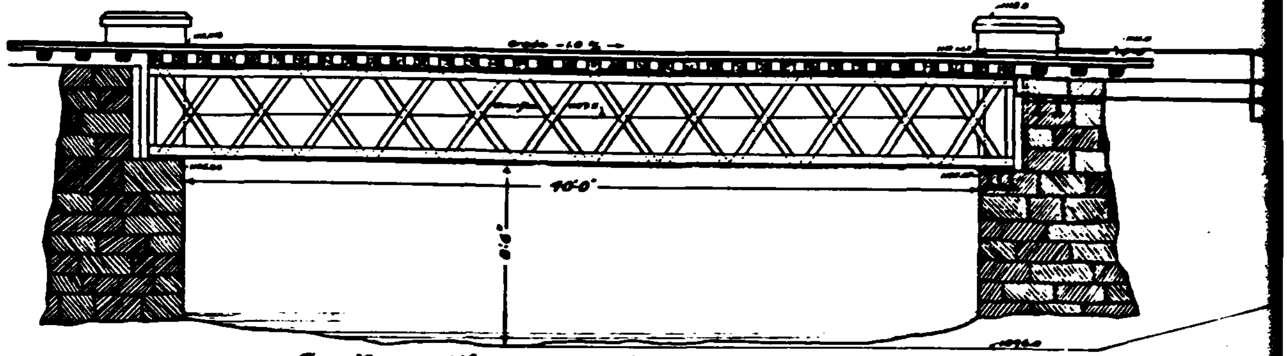
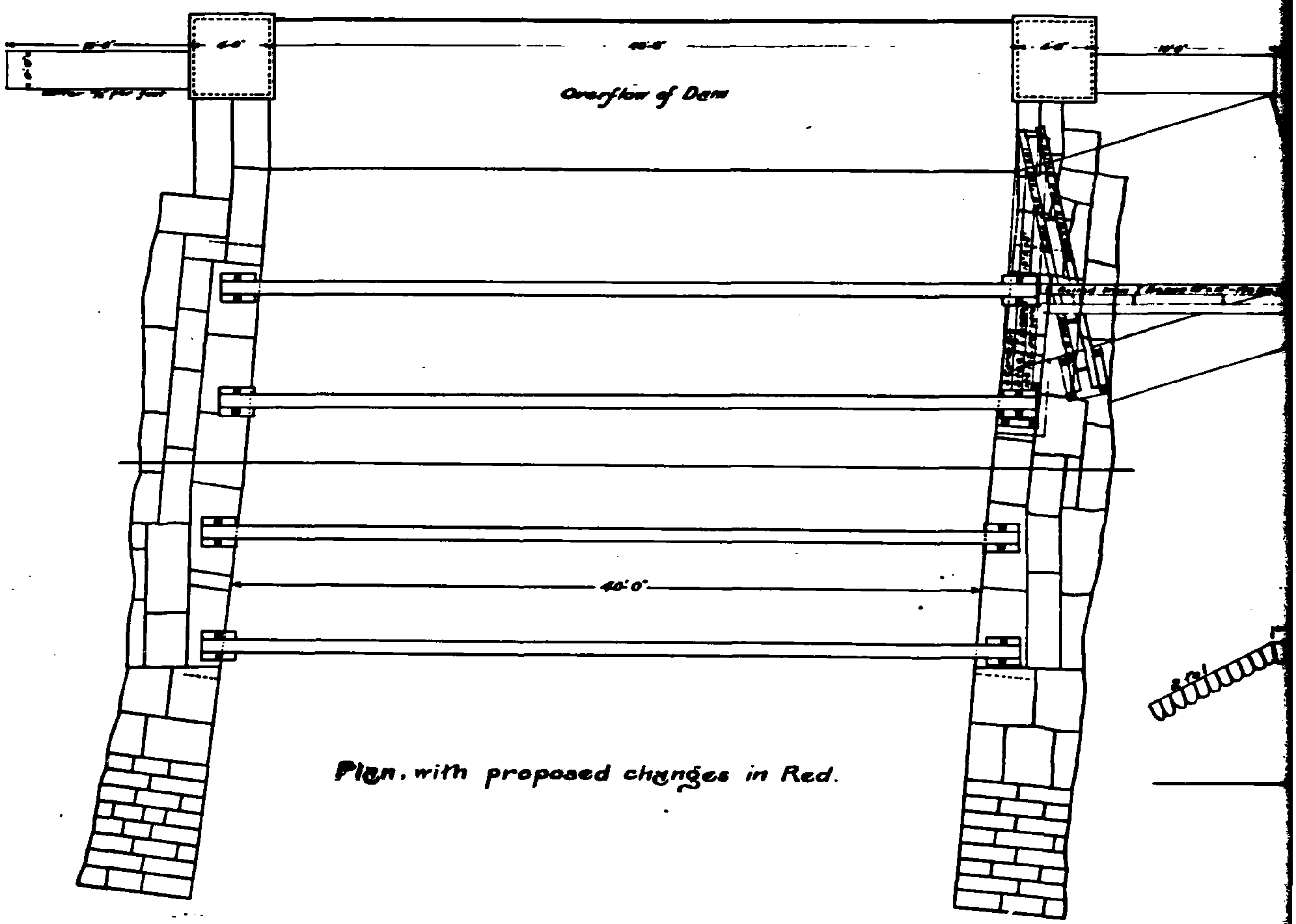

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
QUAKAKE DAM
HAZLETON CITY WATER AUTH.
MAY 1981
PLATE E-VI
4'-0"
3



Section, with proposed changes in Red.



Plan, with proposed changes in Red.

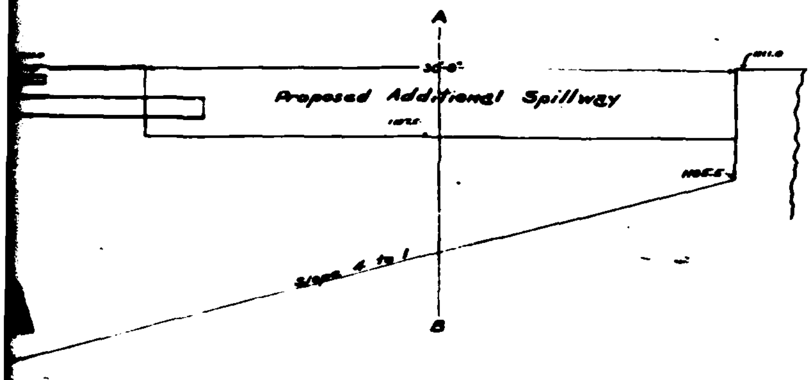
B-47

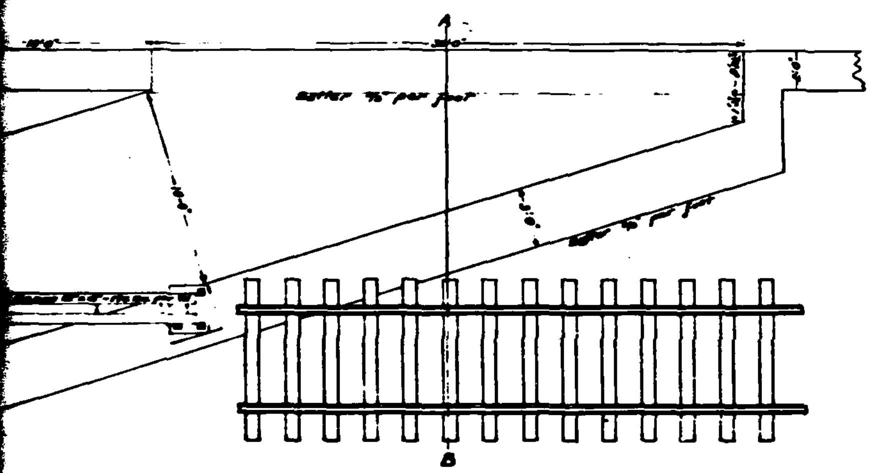
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

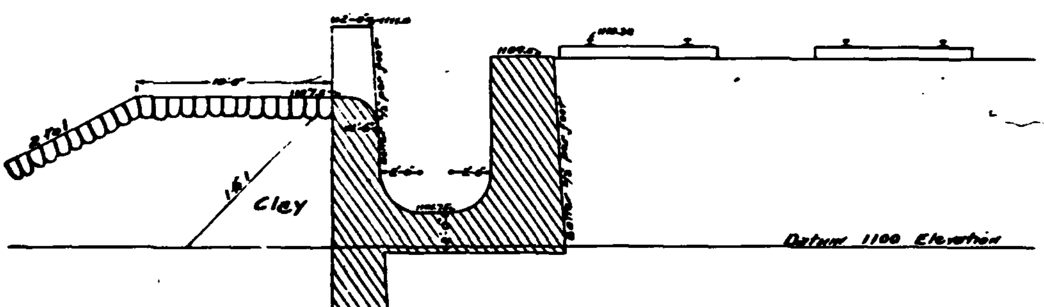
QUAKAKE DAM

HAZLETON CITY WATER AUTH.

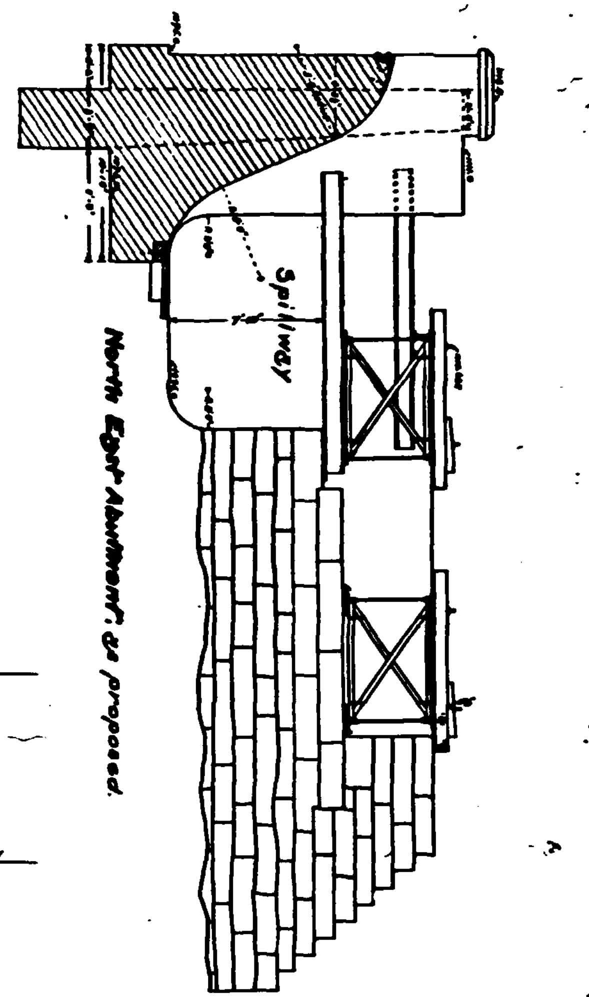
MAY 1981 — PLATE E-VII







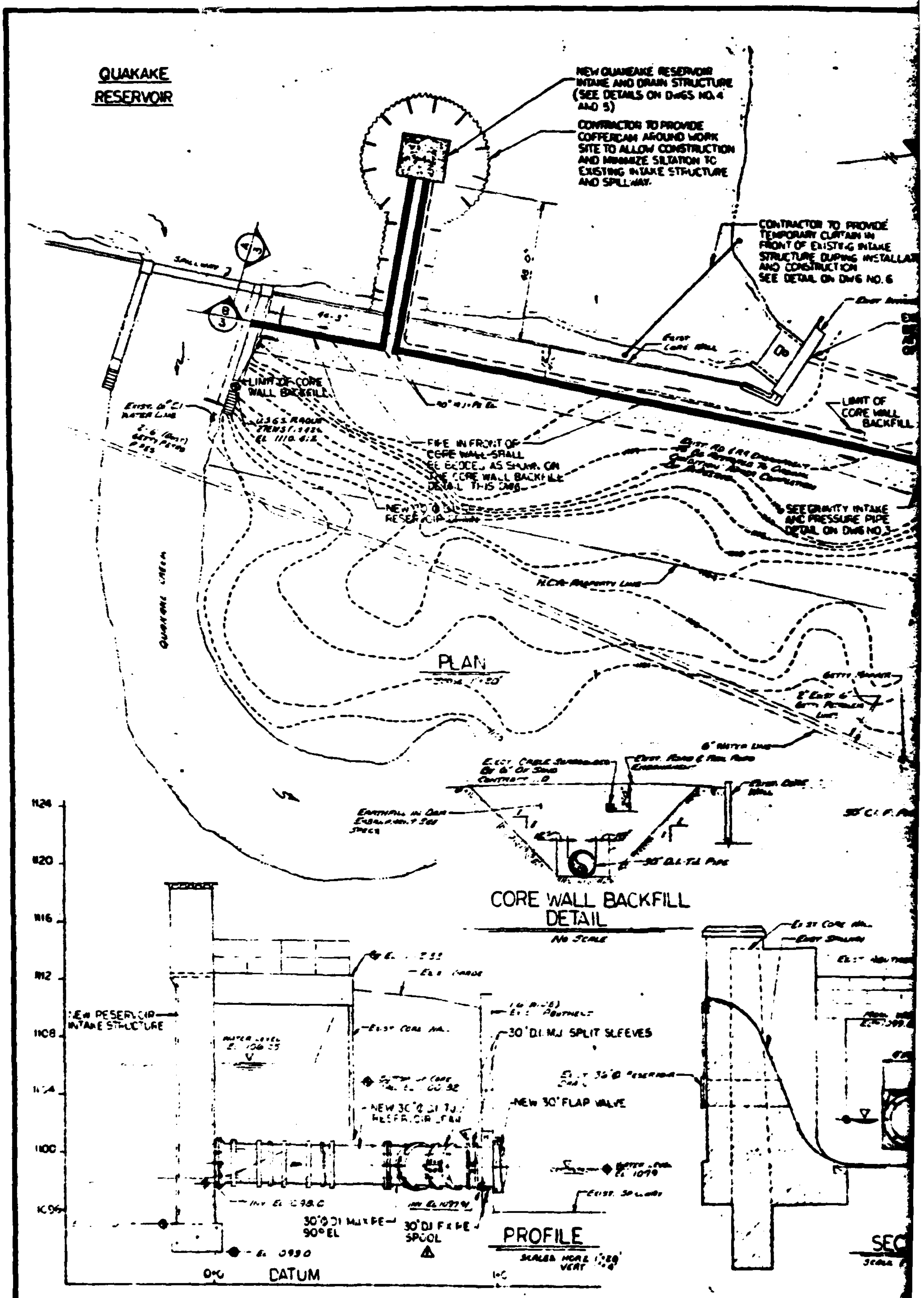
Section on Line AB

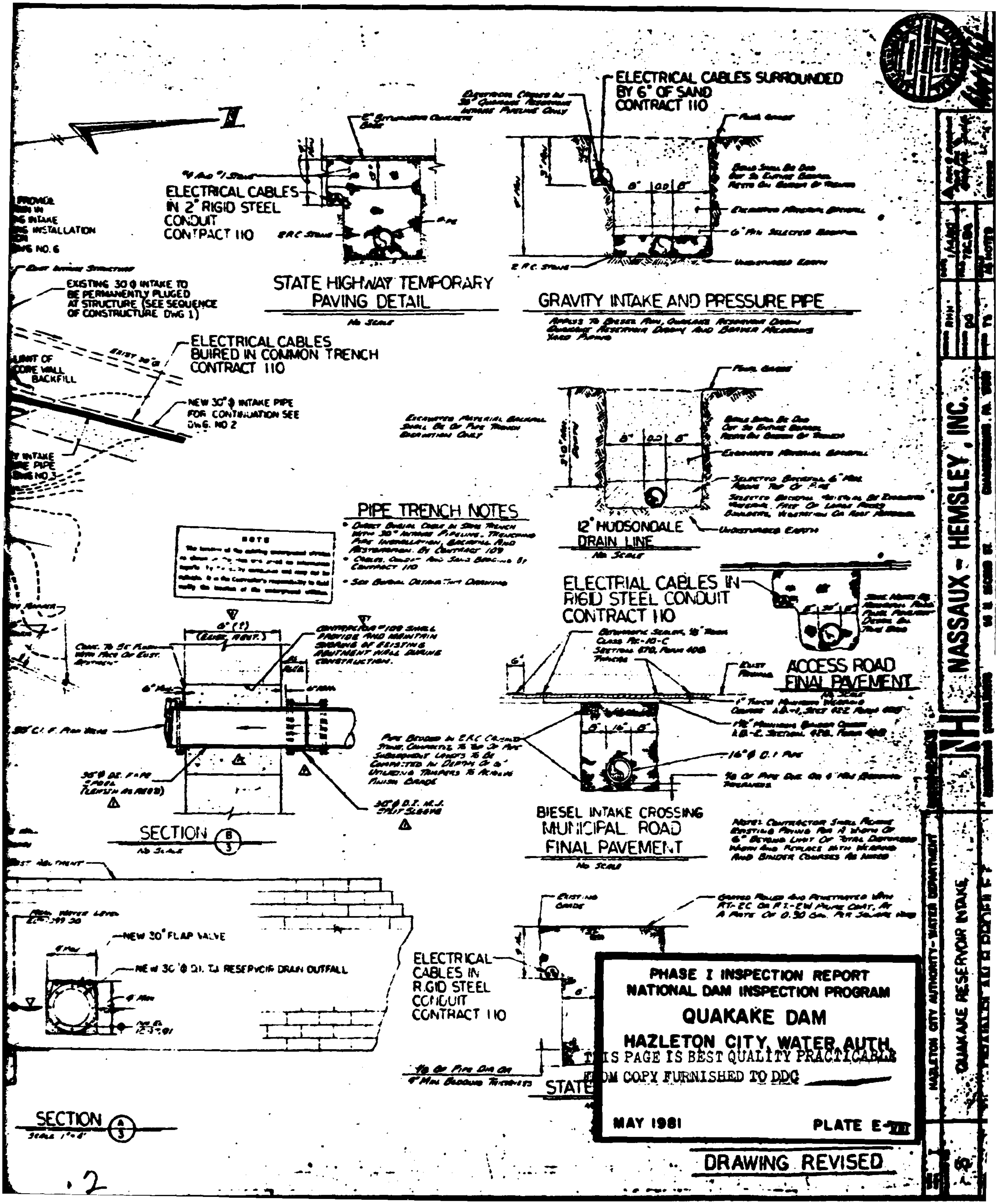


SPILLWAY
FOR
HUDSONDALE RESERVOIR

June 27, 1902 — Eng. Dep. L.V.C.Co.
Scale 4'=1" — Lehigh Div.

2


QUAKAKE RESERVOIR
NEW QUAKAKE RESERVOIR INTAKE AND DRAIN STRUCTURE (SEE DETAILS ON DWGS NO. 4 AND 5)
CONTRACTOR TO PROVIDE COFFERDAM AROUND WORK SITE TO ALLOW CONSTRUCTION AND MINIMIZE SILTATION TO EXISTING INTAKE STRUCTURE AND SPILLWAY.
CONTRACTOR TO PROVIDE TEMPORARY CURTAIN IN FRONT OF EXISTING INTAKE STRUCTURE DURING INSTALLATION AND CONSTRUCTION SEE DETAIL ON DWG NO. 6
LIMIT OF CORE WALL BACKFILL
LIMIT OF CORE WALL BACKFILL
SEE GRAVITY INTAKE AND PRESSURE PIPE DETAIL ON DWG NO. 3
PLAN
CORE WALL BACKFILL DETAIL
No Scale
NEW RESERVOIR INTAKE STRUCTURE
30" D.I. MJ SPLIT SLEEVES
NEW 30" FLAP VALVE
30" D.I. MJ x FE 90° EL
30" DI F x FE SPOOL
DATUM
PROFILE
1124
1120
1116
1112
1108
1104
1100
1096



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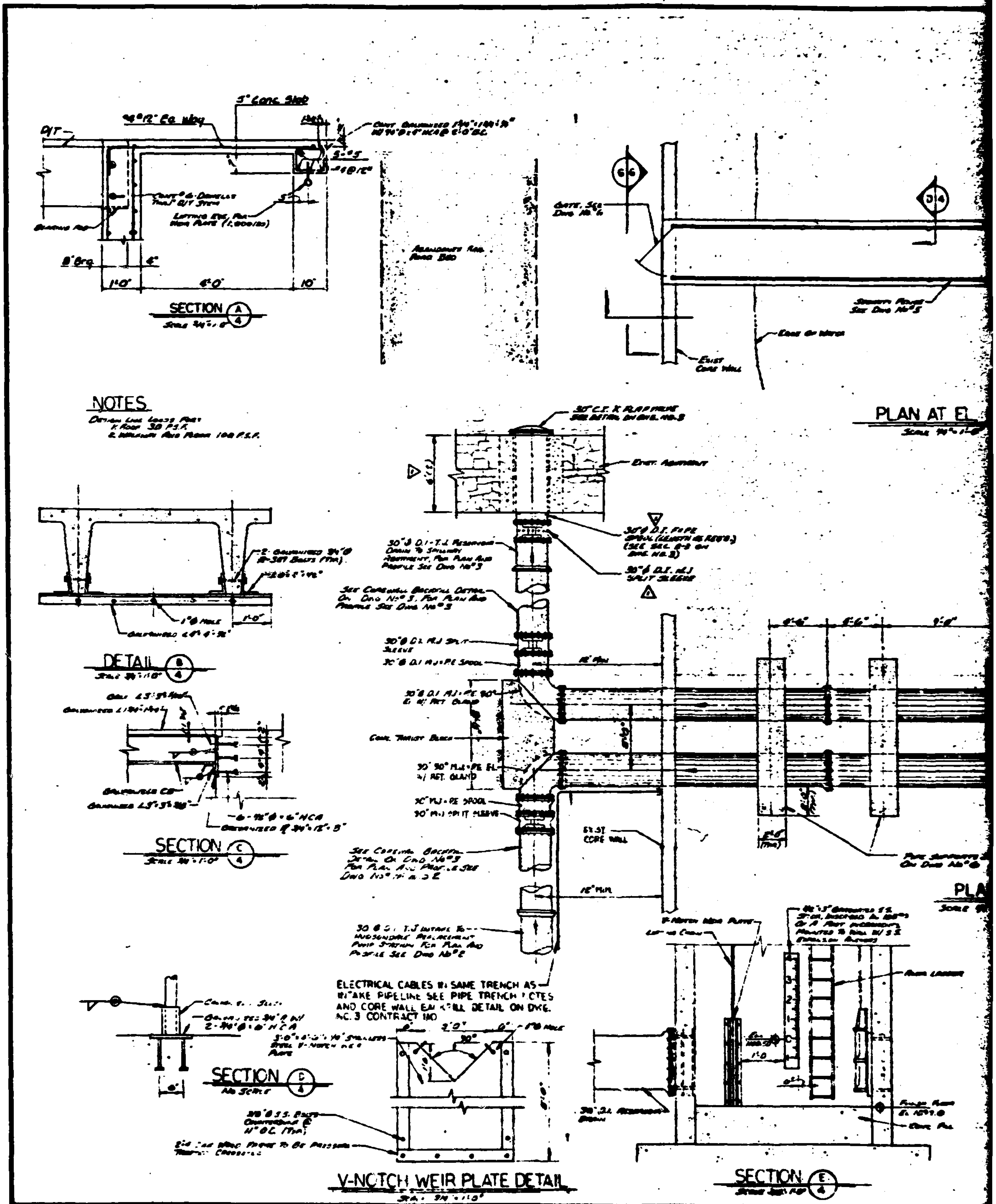
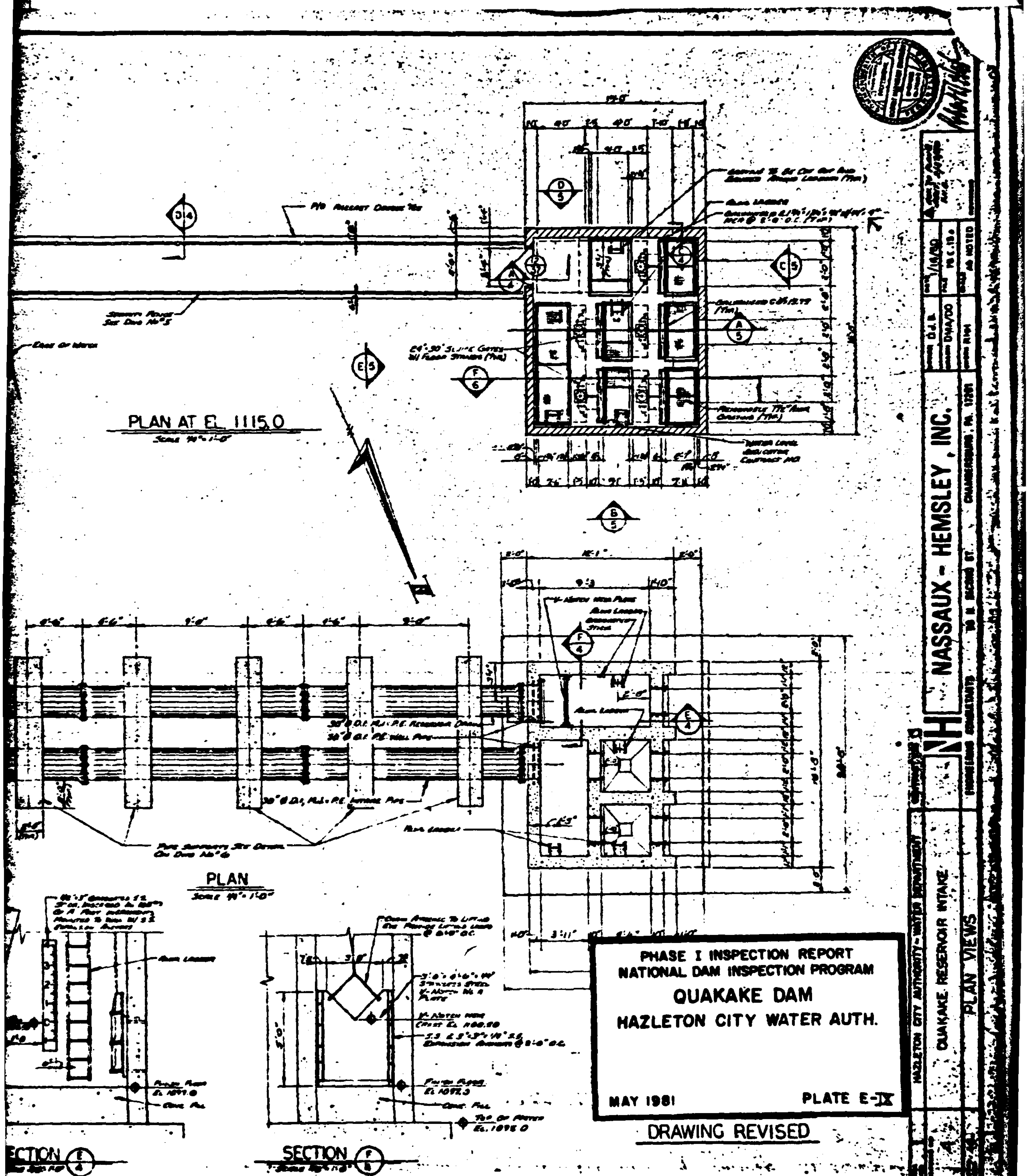


5" Conc. Slab
SECTION A 4
NOTES
DETAIL B 4
SECTION C 4
SECTION D 4
No Scale
V-NOTCH WEIR PLATE DETAIL
SECTION E 4
PLAN AT EL
ELECTRICAL CABLES IN SAME TRENCH AS
INTAKE PIPELINE SEE PIPE TRENCH NOTES
AND CORE WALL BACKFILL DETAIL ON DWG.
NO. 3 CONTRACT NO



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NATIONAL DAM INSPECTION PROGRAM

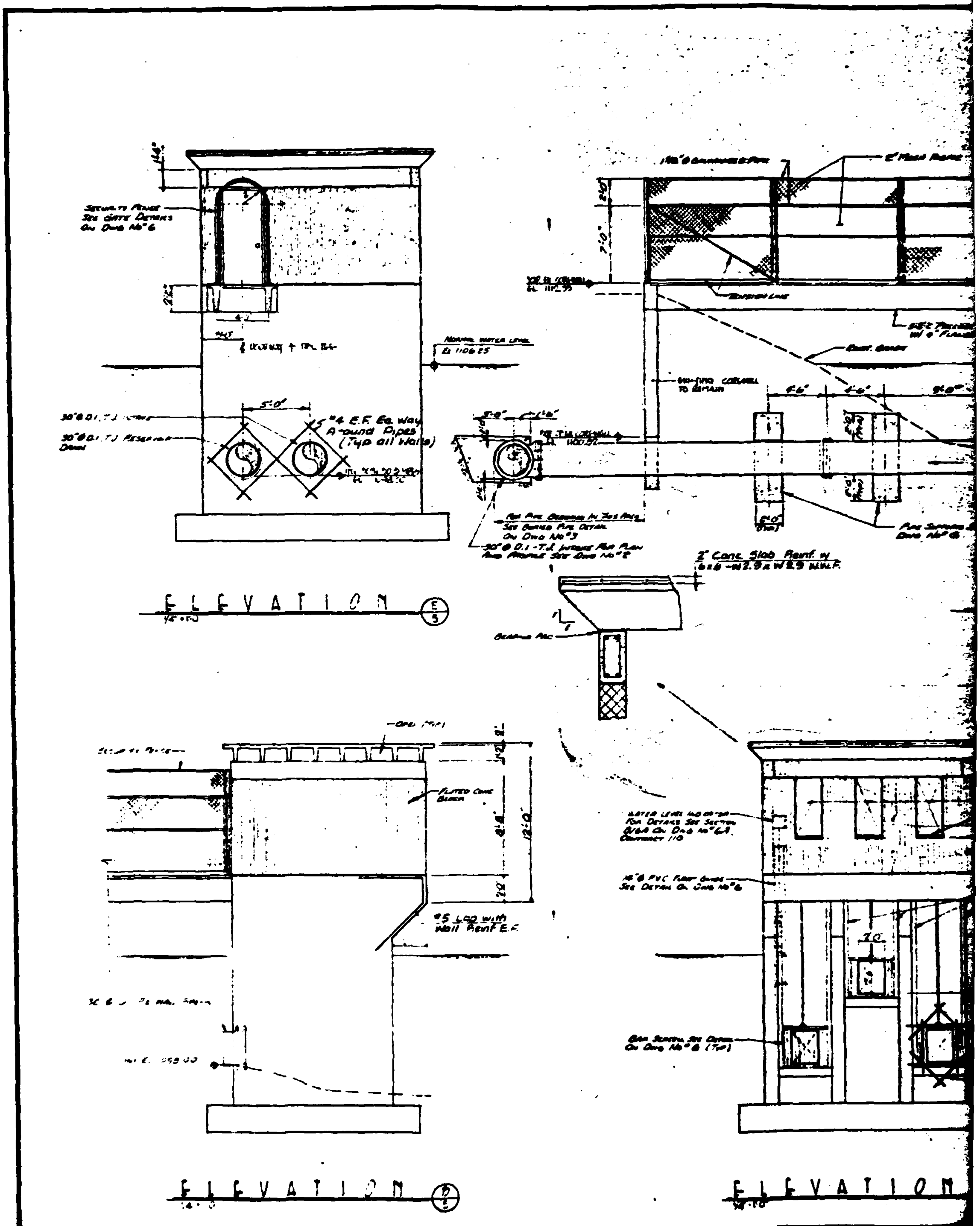
QUAKAKE DAM

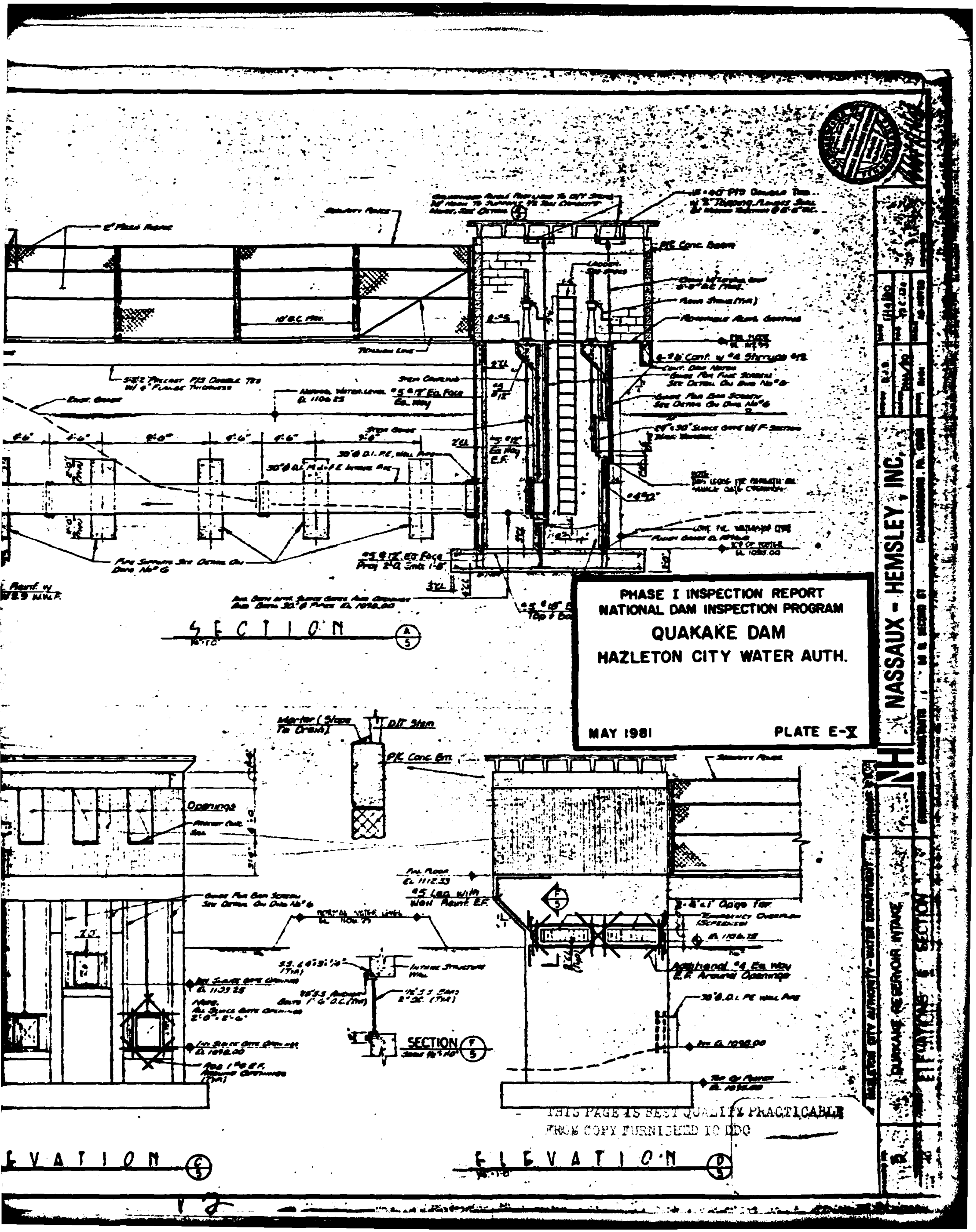
HAZLETON CITY WATER AUTH.

MAY 1981

PLATE E-IX

DRAWING REVISED


Security Fence
See Gate Details
On Dwg No 6
Normal Water Level
El 1106.25
5'-0"
#4 E.F. Ea. way
Around Pipes
(Typ all Walls)
See Buried Pipe Detail
On Dwg No 3
2" Conc Slab Reinf. w
6x6 -W2.9 x W2.9 W.W.F.
Bearing Pad
ELEVATION
Flared Conc
Beach
12'-0"
#5 Lap with
Wall Reinf E.F.
Water Level Indicator
On Dwg No 6A
Contract 110
16" Ø PVC Flap Gate
See Detail On Dwg No 6
7'-0"
Bar Screen See Detail
On Dwg No 6 (Typ)
ELEVATION
ELEVATION


PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
QUAKAKE DAM
HAZLETON CITY WATER AUTH.
MAY 1981
PLATE E-X
NASSAUX - HEMSLEY, INC.
SECTION A/5
ELEVATION C/5
ELEVATION D/5
SECTION F/5
P/C Conc. Beam
P/C Conc. Bm.
Mortar (Slope To Drain)
D/T Stem
Openings
Additional #4 Ea. Way E.F. Around Openings
30" Ø D.I. PE Wall Pipe
Fin. Floor El. 1112.33
#5 Lap with Wall Reinf. E.F.
6-#9 b Cont. w/ #4 Stirrups @ 12
Fin. Floor El. 1112.33

APPENDIX F

GEOLOGY

QUAKAKE DAM

GENERAL GEOLOGY

The bedrock at Quakake Dam is of the Mauch Chunk Formation. This formation consists of grayish - red shale, siltstone, sandstone, and some conglomerate. There should be some alluvium in the valley bottom, but this material should be relatively thin, probably less than 1m thick. Bedrock is exposed along the left upstream slope of the lake. This bedrock is a sandstone with beds varying from 4 inches to 1 foot thick with conglomerate at the base of some beds.

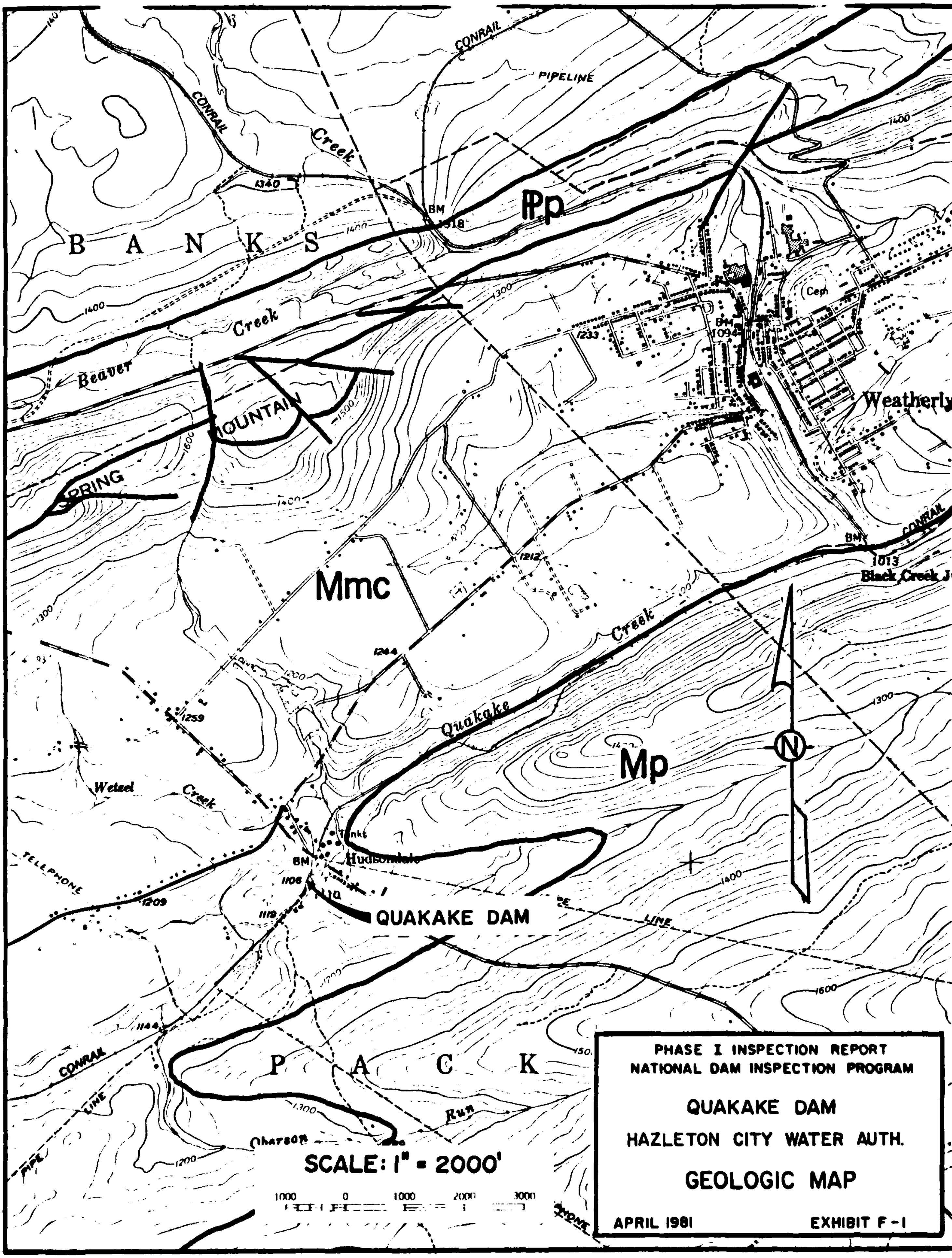
Legend
(Bedrock)

¶p POTTSVILLE GROUP - Gray conglomerate, fine- to coarse- grained sandstone, and siltstone and shale containing minable anthracite coals. Includes three formations. In descending order: Sharp Mountain--conglomerate and conglomerate sandstones; Schuylkill--sandstone and conglomerate sandstone; Tumbling Run--conglomeratic sandstone and sandstone.

Mmc MAUCH CHUNK FORMATION - Grayish-red shale, siltstone, sandstone, and some conglomerate; some local nonred zones. Includes Loyalhanna Member--crossbedded, sandy limestone at base of south-central and southwestern Pennsylvania; also includes Greenbrier Limestone Member

and Wymps Gap and Deer Valley Limestones, which are tongues of the Greenbrier. Along Allegheny Front from Blair County to Sullivan County, Loyalhanna Member is greenish-gray, calcareous, crossbedded sandstone.

Mp POCONO FORMATION - Light-gray to buff or light-olive-gray, medium-grained, crossbedded sandstone and minor siltstone, commonly conglomeratic at base and in middle; medial conglomerate, where present, is used to divide into Mount Carbon and Beckville Members; equivalent to Burgoon Sandstone of Allegheny Plateau.



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NATIONAL DAM INSPECTION PROGRAM

QUAKAKE DAM

HAZLETON CITY WATER AUTH.

GEOLOGIC MAP

APRIL 1981 EXHIBIT F-1

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FILM